US006243643B1

(12) United States Patent
Uematsu

(10) Patent No.: US 6,243,643 B1
(45) Date of Patent: Jun. 5, 2001

(54) VEHICLE CONTROL APPARATUS FOR CALCULATING CONTROL VALUE WITH BASIC VALUE AND CORRECTION VALUE

(75) Inventor: **Yoshitaka Uematsu**, Anjo (JP)

(73) Assignee: **Denso Corporation**, Kariya (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/372,751**

(22) Filed: **Aug. 11, 1999**

(30) **Foreign Application Priority Data**

Sep. 29, 1998 (JP) 10-274884

(51) **Int. Cl.**[7] **G06F 19/00**

(52) **U.S. Cl.** **701/115**; 701/103

(58) **Field of Search** 701/101, 102, 701/103, 104, 105, 115

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,932,376 * 6/1990 Linder et al. 701/115
5,050,562 * 9/1991 Ishii et al. 701/103
5,091,858 * 2/1992 Paielli 701/115
5,200,900 * 4/1993 Adrain et al. 701/115
5,523,948 * 6/1996 Adrain 701/115
5,826,211 * 10/1998 Kobayashi 701/115
5,951,619 * 9/1999 Merl et al. 701/115

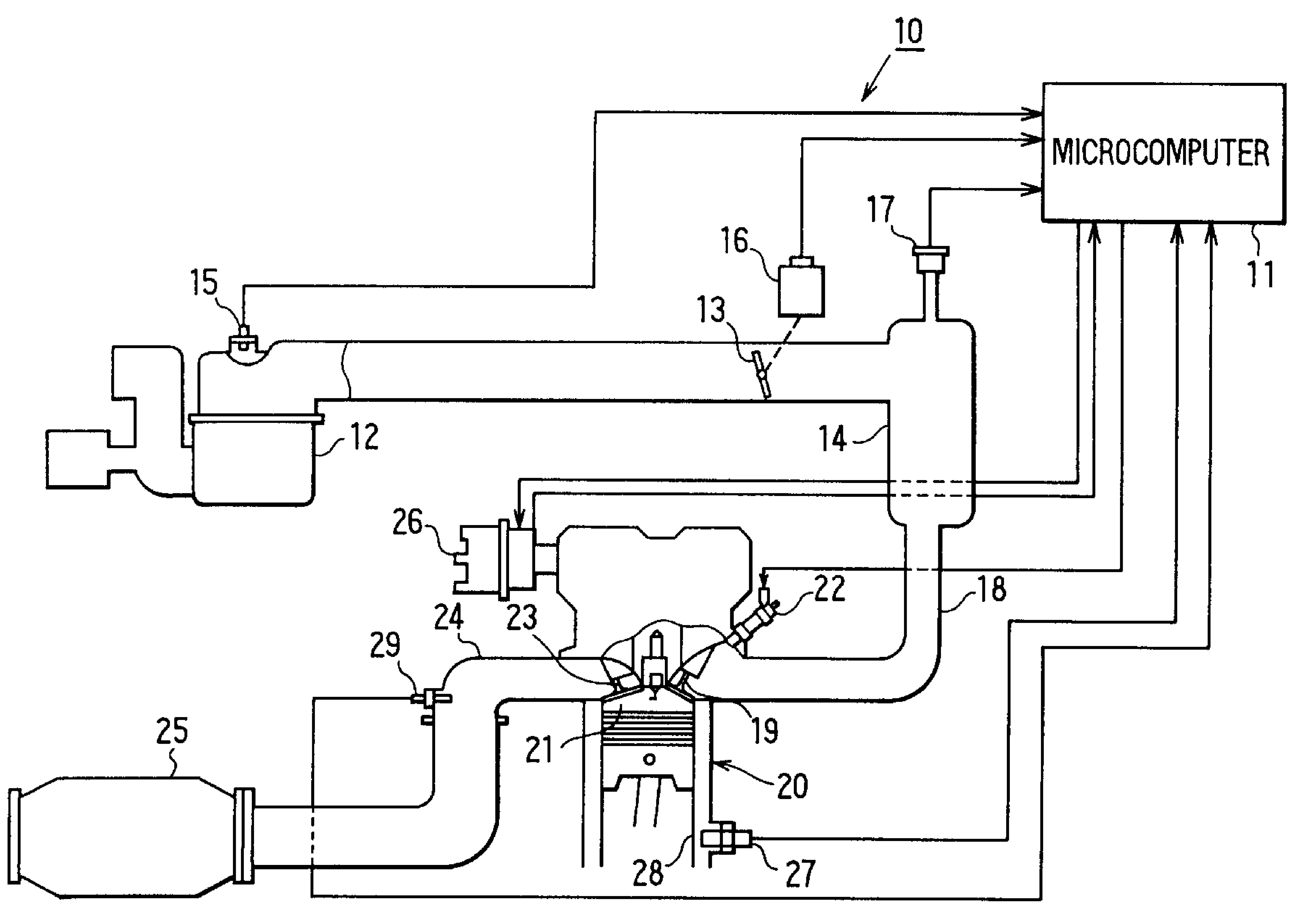
* cited by examiner

Primary Examiner—Willis R. Wolfe
(74) *Attorney, Agent, or Firm*—Nixon & Vanderhye

(57) **ABSTRACT**

A control apparatus for vehicles has a memory, which includes a plurality of correction information tables and a designation information table. The correction information tables stores a plurality of address data indicating types of correction calculations, and a plurality of correction terms to be calculated based on operating conditions in dependence on the types of correction calculations. The designation information table is for designates sequentially the plurality of correction information tables based on the types of correction calculations. A processing unit calculates sequentially a plurality of control values based on the address data and the correction terms with reference to the correction information tables designated by the designation information table, and calculating a final control value from the sequentially calculated control values.

15 Claims, 11 Drawing Sheets



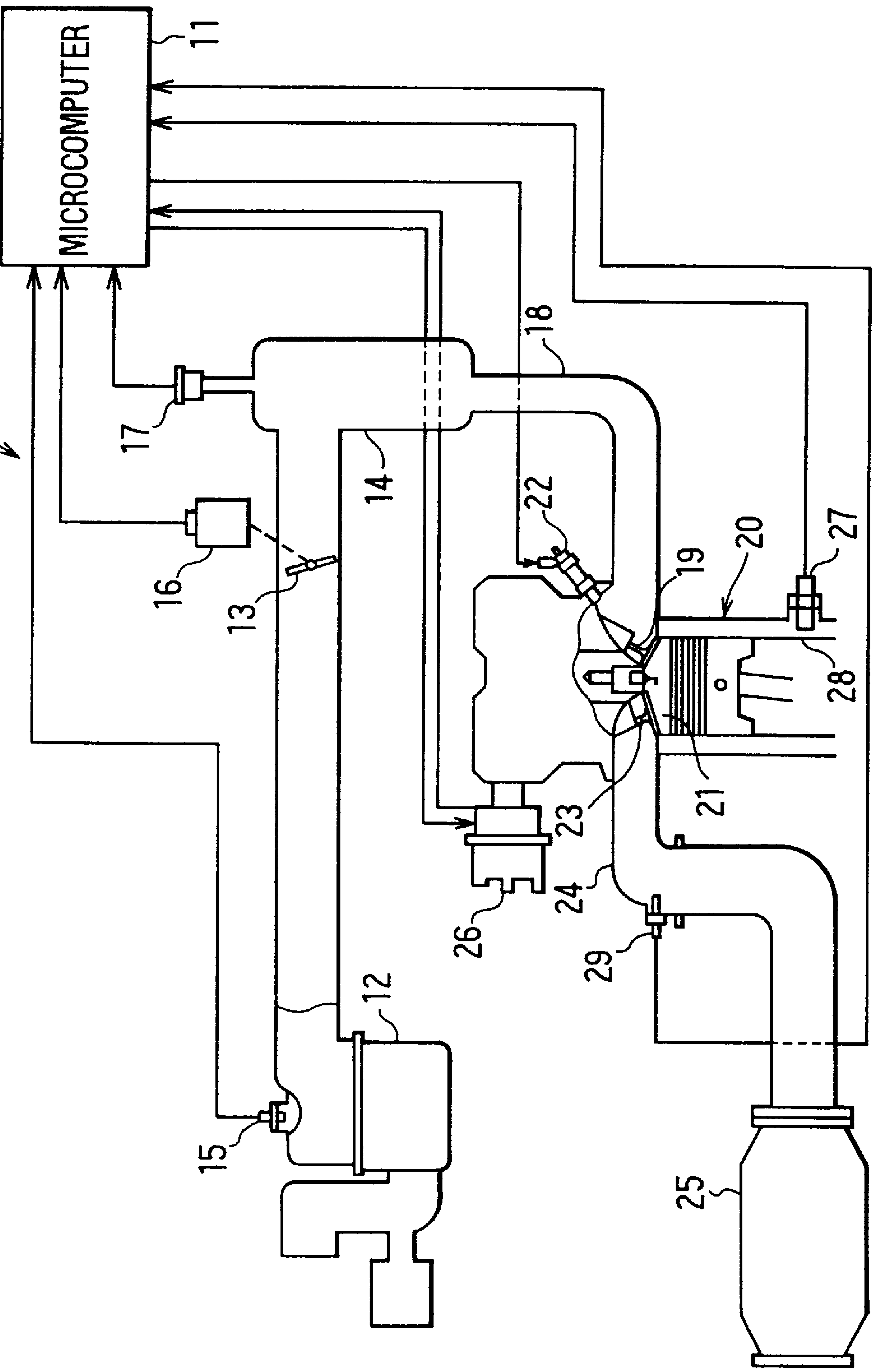

MICROCOMPUTER
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29

FIG. 1

10

FIG. 2

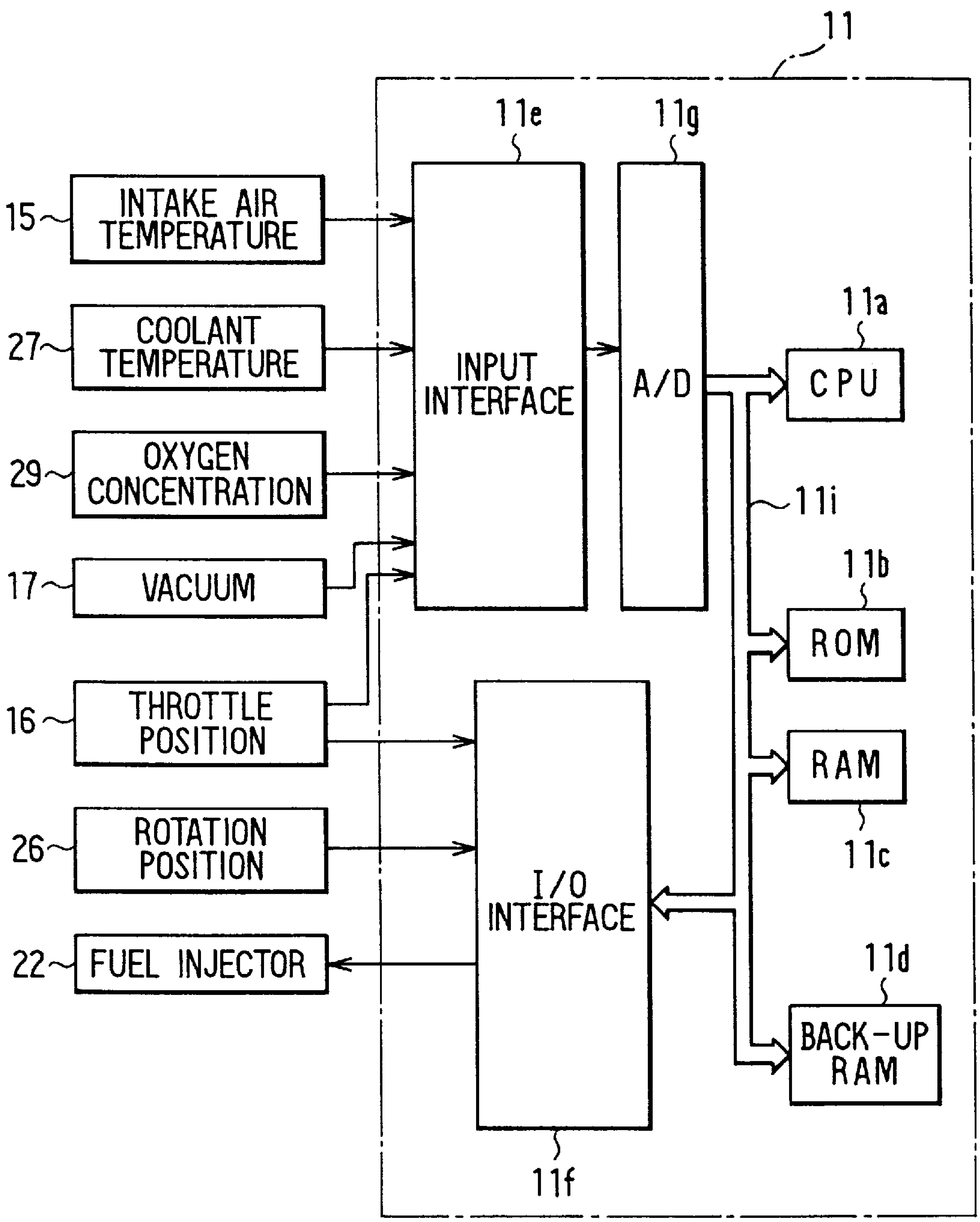

11
11e
11g
15
INTAKE AIR TEMPERATURE
27
COOLANT TEMPERATURE
29
OXYGEN CONCENTRATION
17
VACUUM
16
THROTTLE POSITION
26
ROTATION POSITION
22
FUEL INJECTOR
INPUT INTERFACE
A/D
11a
CPU
11i
11b
ROM
RAM
11c
I/O INTERFACE
11d
BACK-UP RAM
11f

FIG. 3

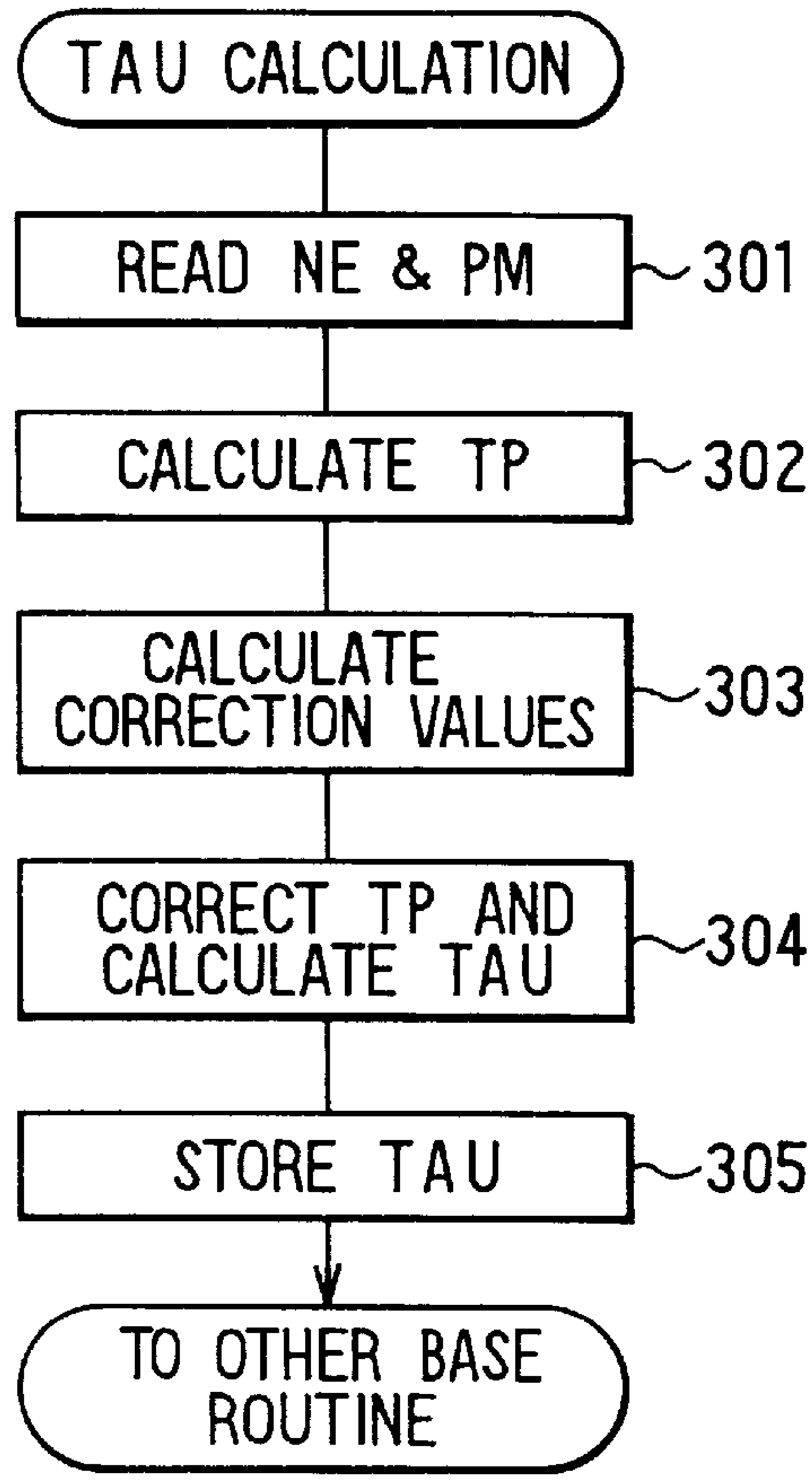

TAU CALCULATION
READ NE & PM
301
CALCULATE TP
302
CALCULATE CORRECTION VALUES
303
CORRECT TP AND CALCULATE TAU
304
STORE TAU
305
TO OTHER BASE ROUTINE

FIG. 4

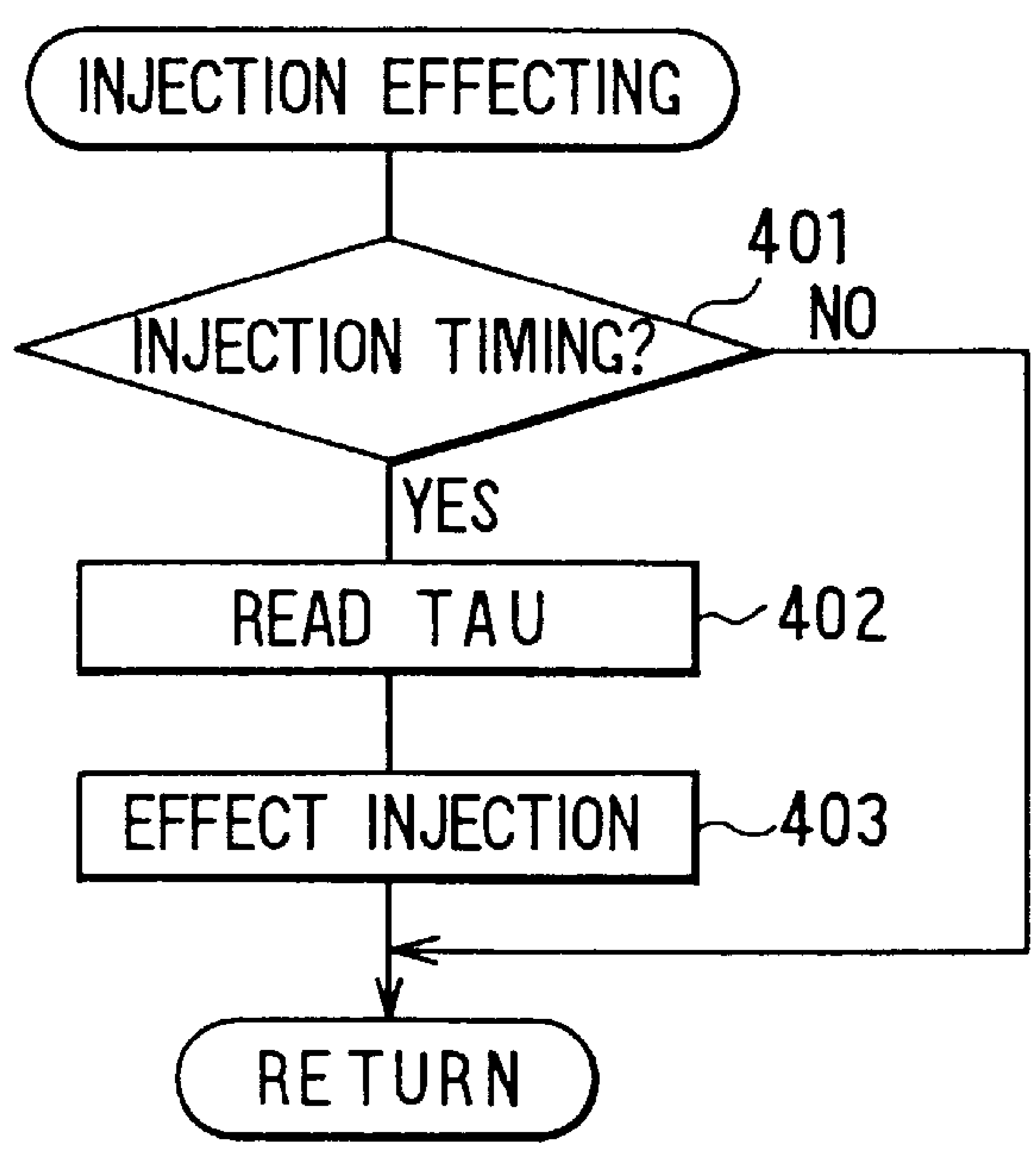

INJECTION EFFECTING
401
INJECTION TIMING?
NO
YES
READ TAU
402
EFFECT INJECTION
403
RETURN

FIG. 5

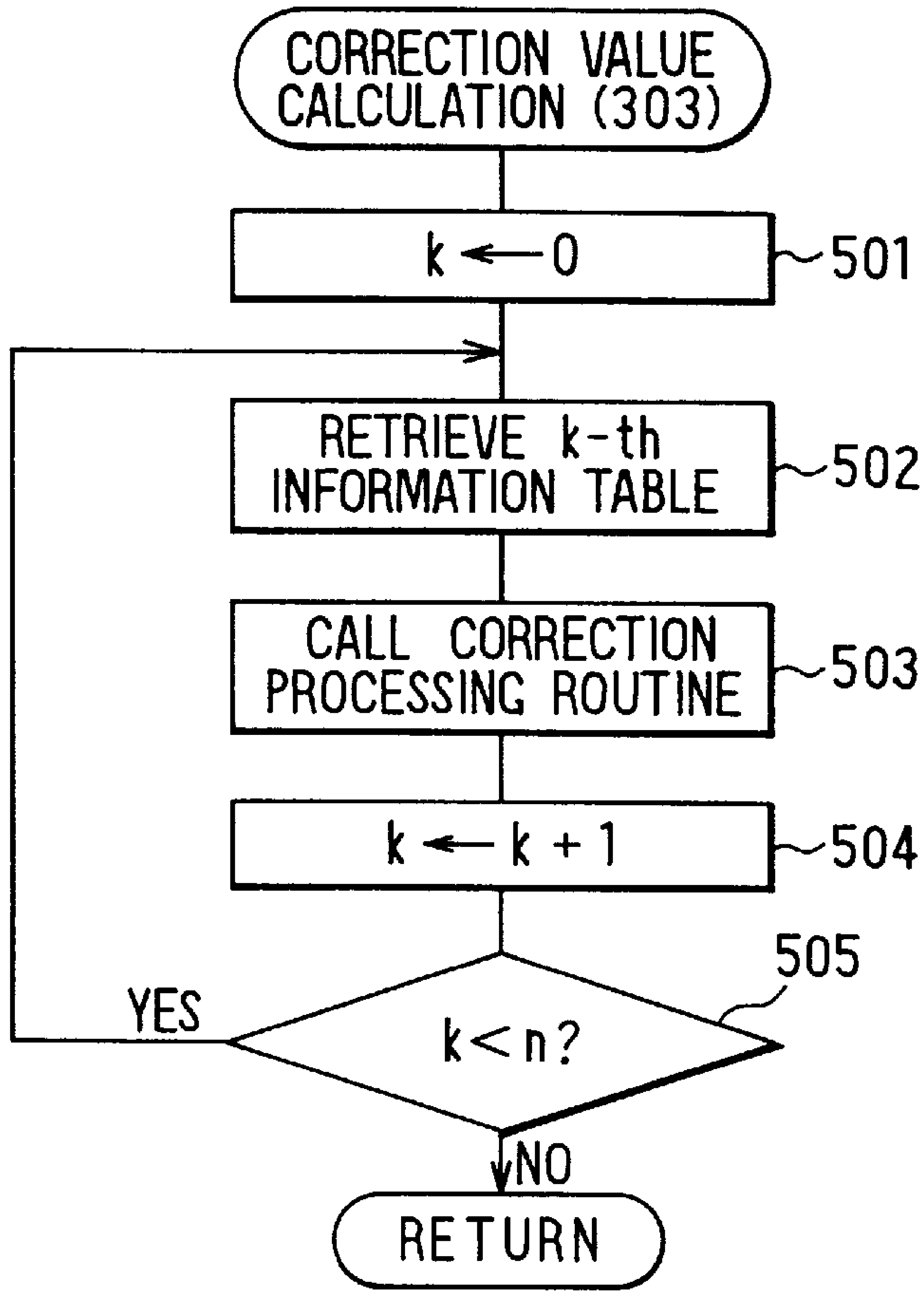


FIG. 6

k	INFORMATION TABLE NUMBER n
0	HEAD ADDRESS OF INFORMATION TABLE 1(1000h)
1	HEAD ADDRESS OF INFORMATION TABLE 2(1100h)
2	HEAD ADDRESS OF INFORMATION TABLE 3(1200h)
3	HEAD ADDRESS OF INFORMATION TABLE 4(1300h)

FIG. 7

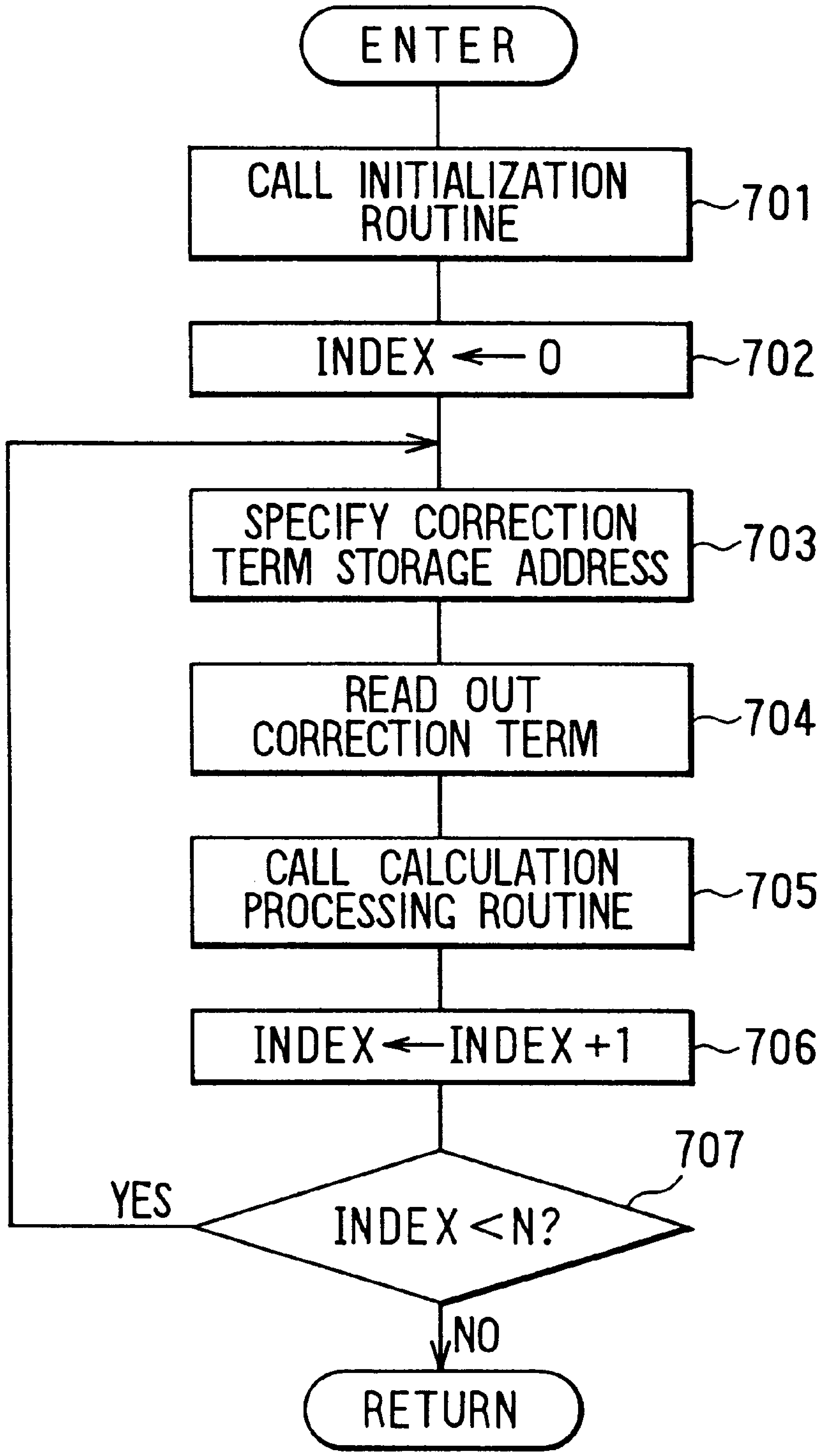

ENTER
CALL INITIALIZATION ROUTINE
701
INDEX ← 0
702
SPECIFY CORRECTION TERM STORAGE ADDRESS
703
READ OUT CORRECTION TERM
704
CALL CALCULATION PROCESSING ROUTINE
705
INDEX ← INDEX +1
706
707
INDEX <N?
YES
NO
RETURN

FIG. 8A

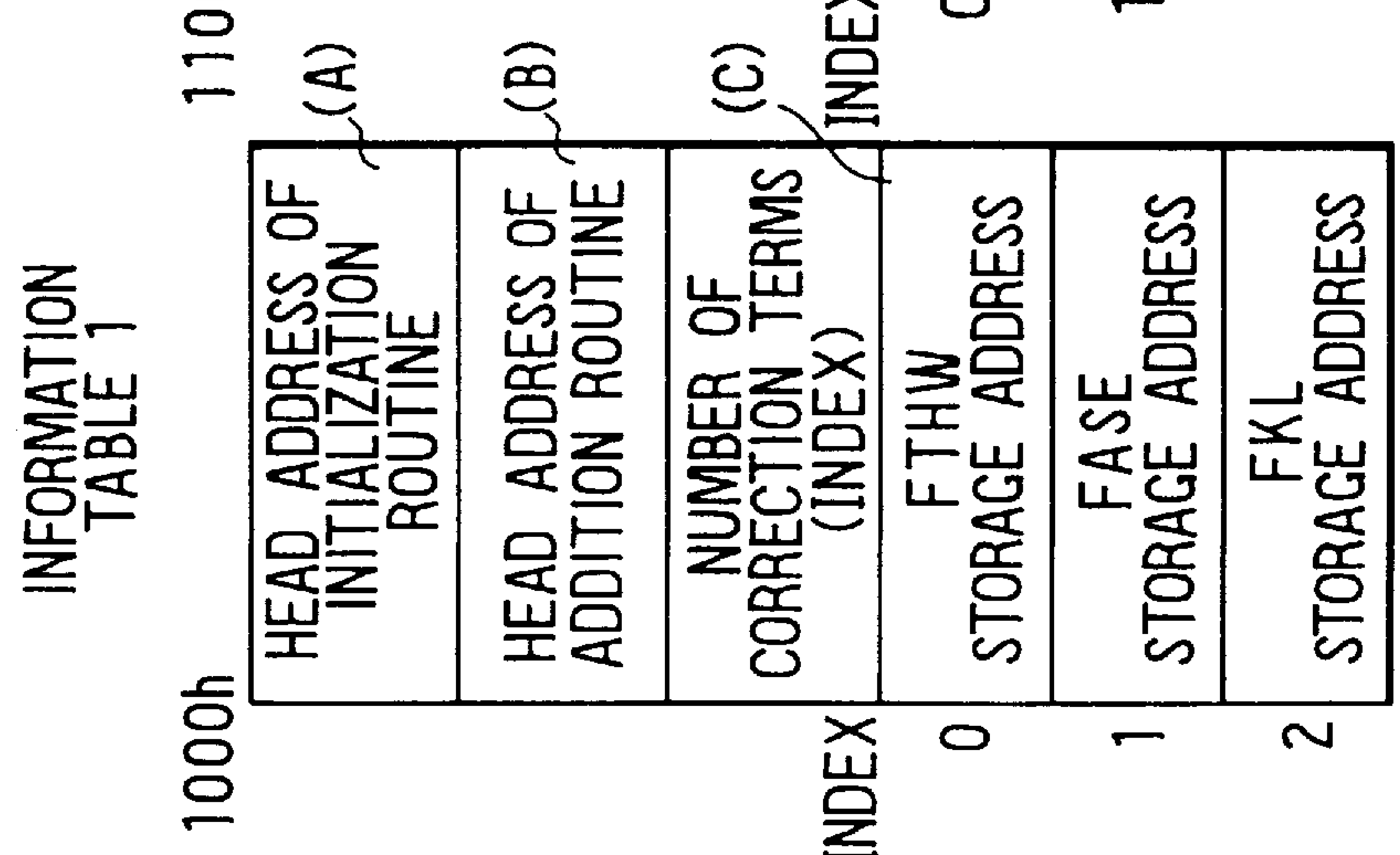


FIG. 8B

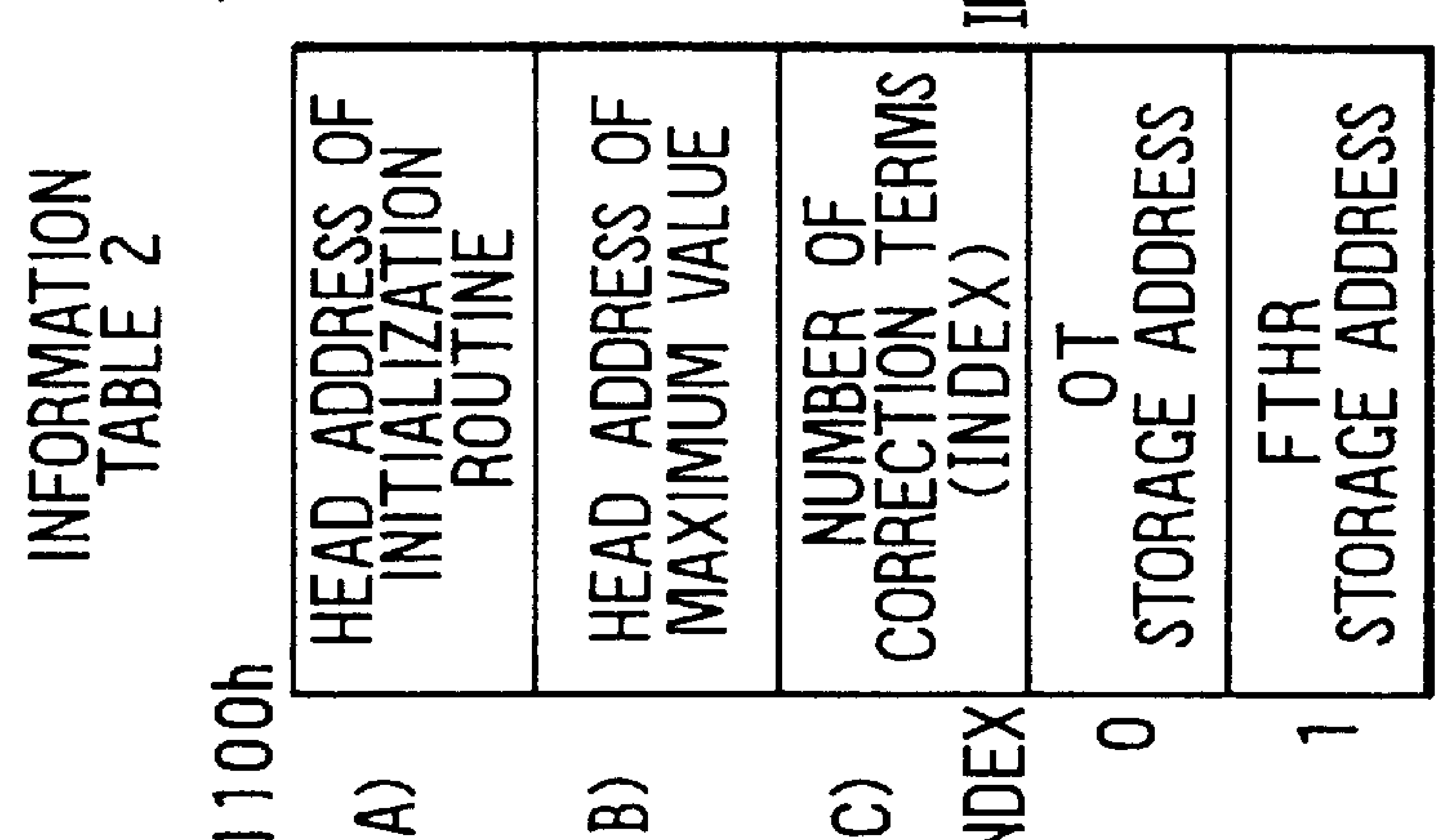


FIG. 8C

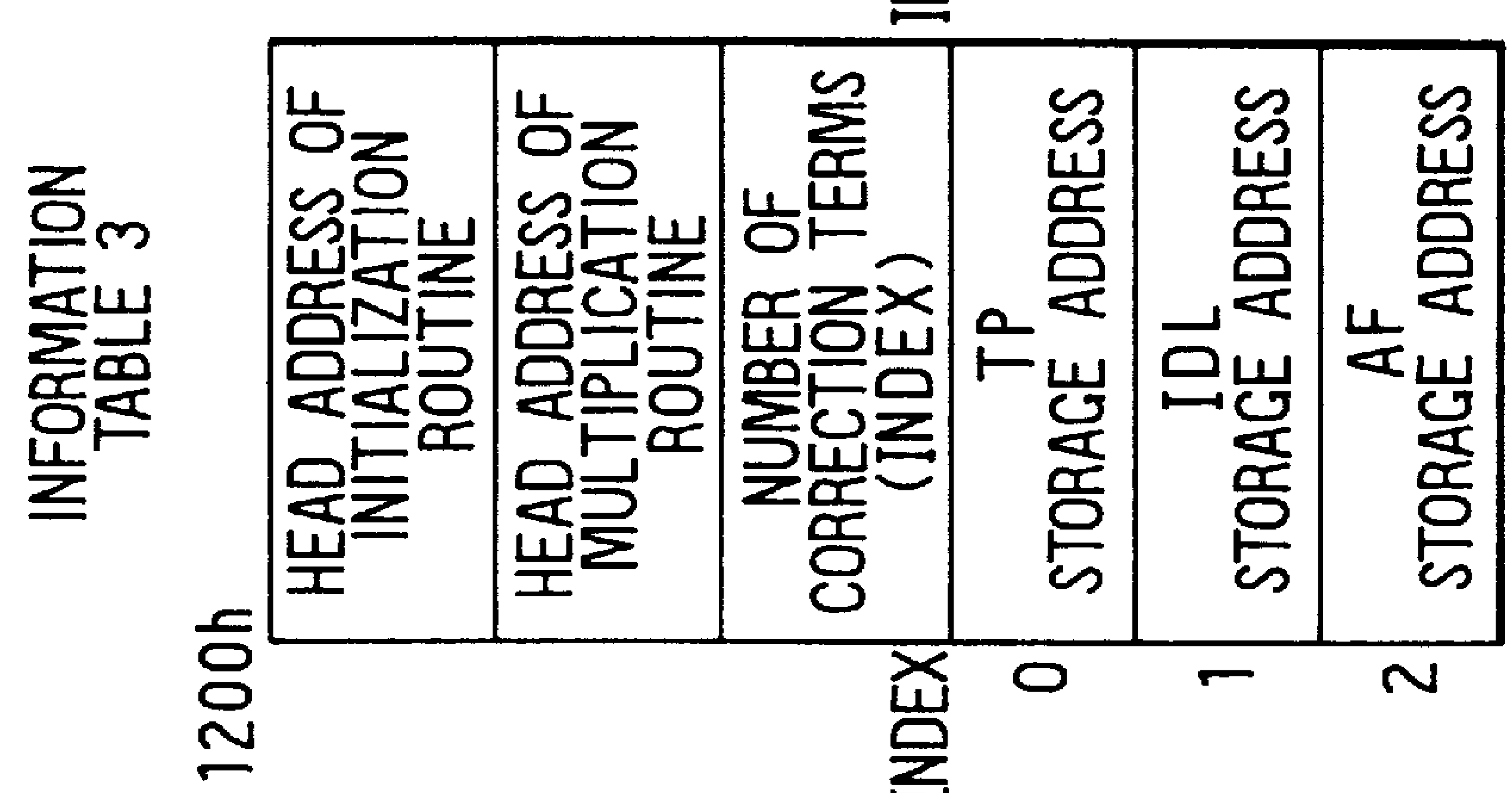


FIG. 8D

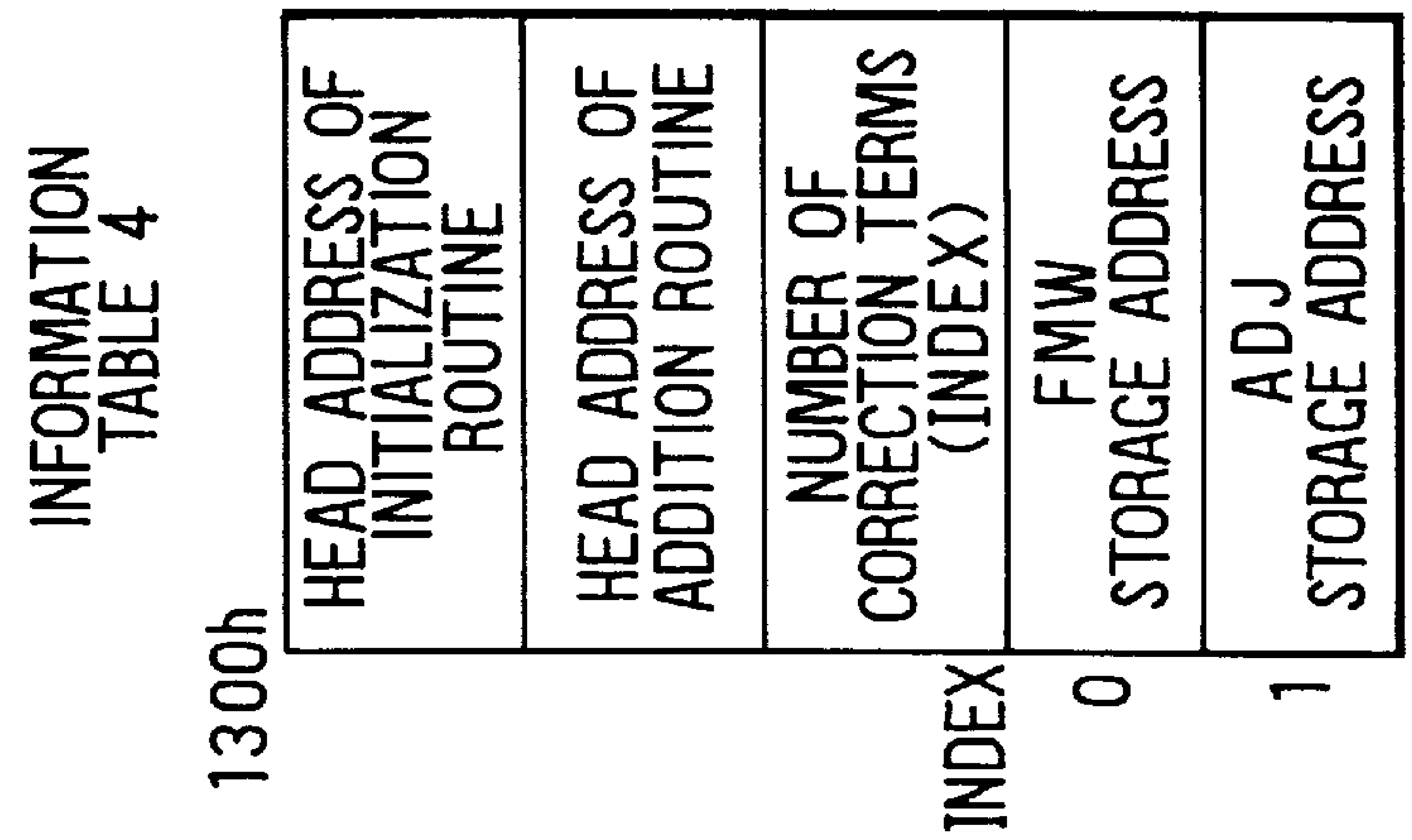


FIG. 9

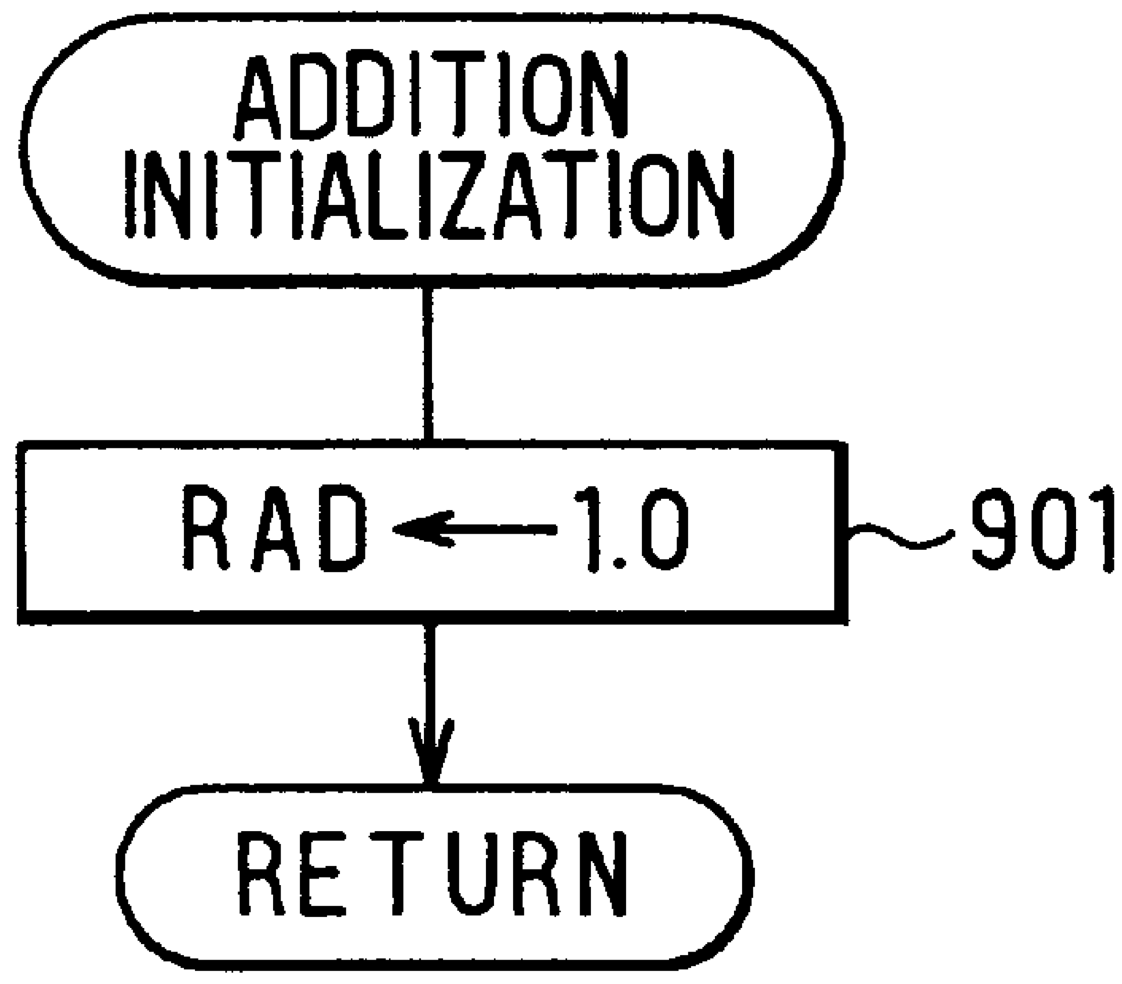

ADDITION INITIALIZATION
RAD ← 1.0
901
RETURN

FIG. 10

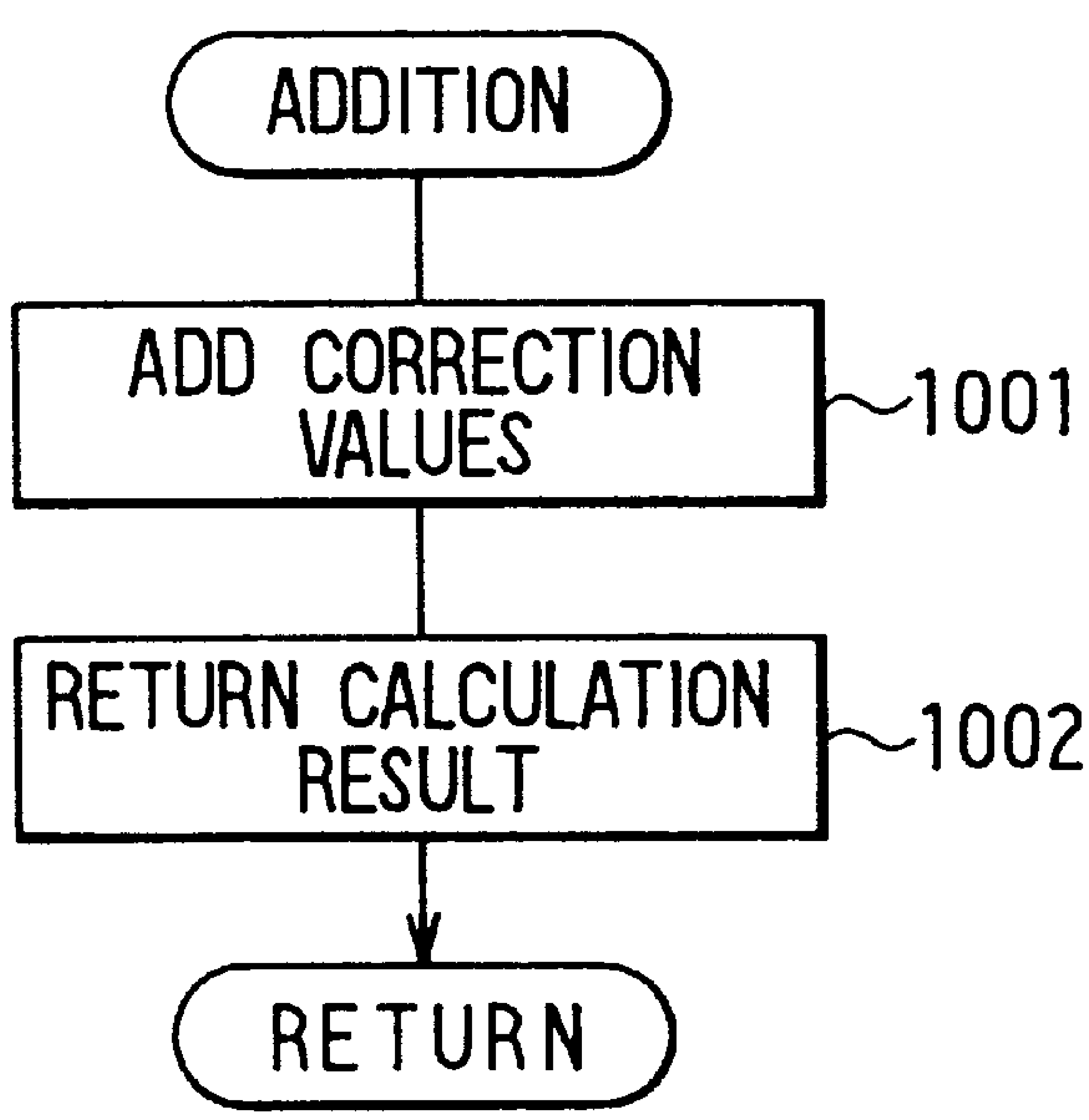

ADDITION
ADD CORRECTION VALUES
1001
RETURN CALCULATION RESULT
1002
RETURN

FIG. 11

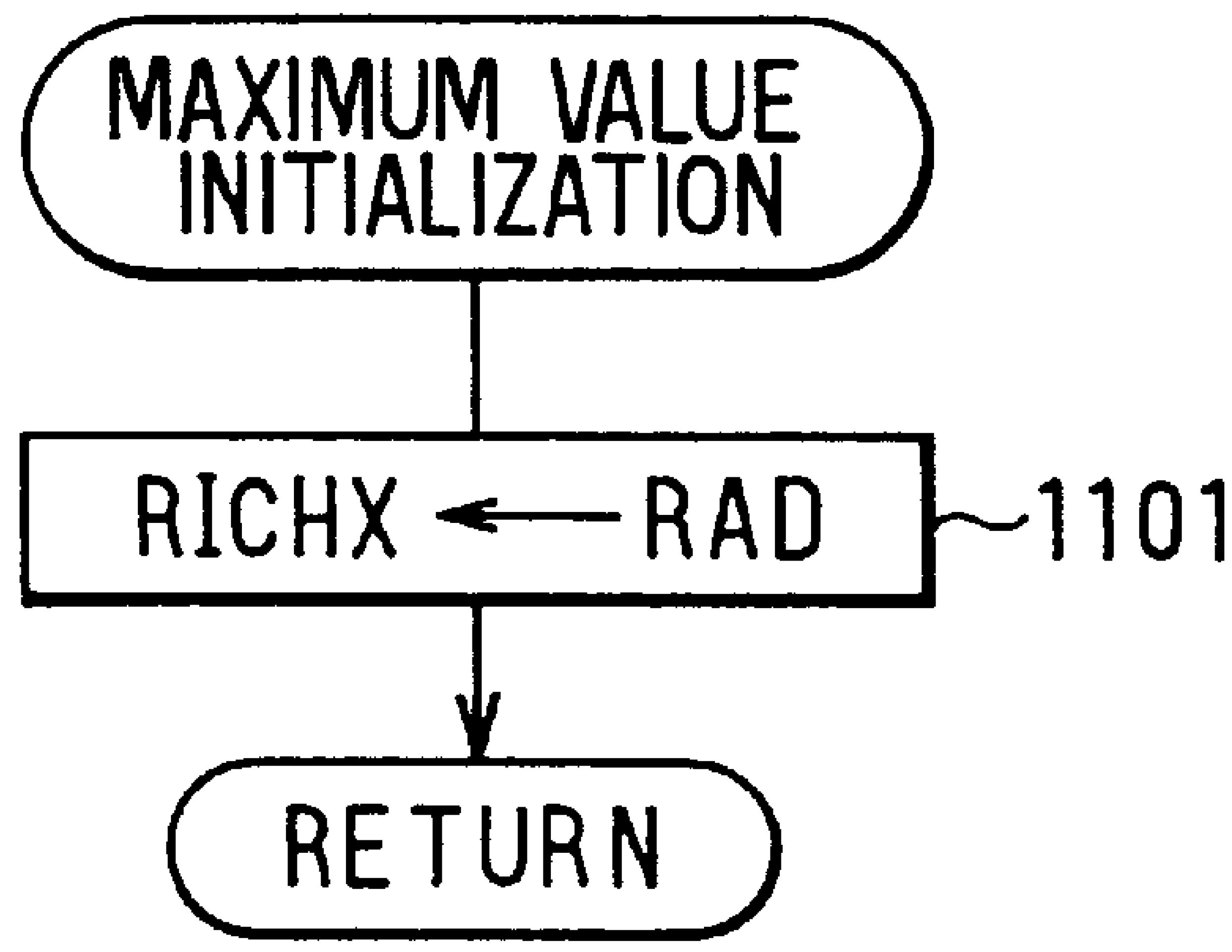

MAXIMUM VALUE INITIALIZATION
RICHX ← RAD
1101
RETURN

FIG. 12

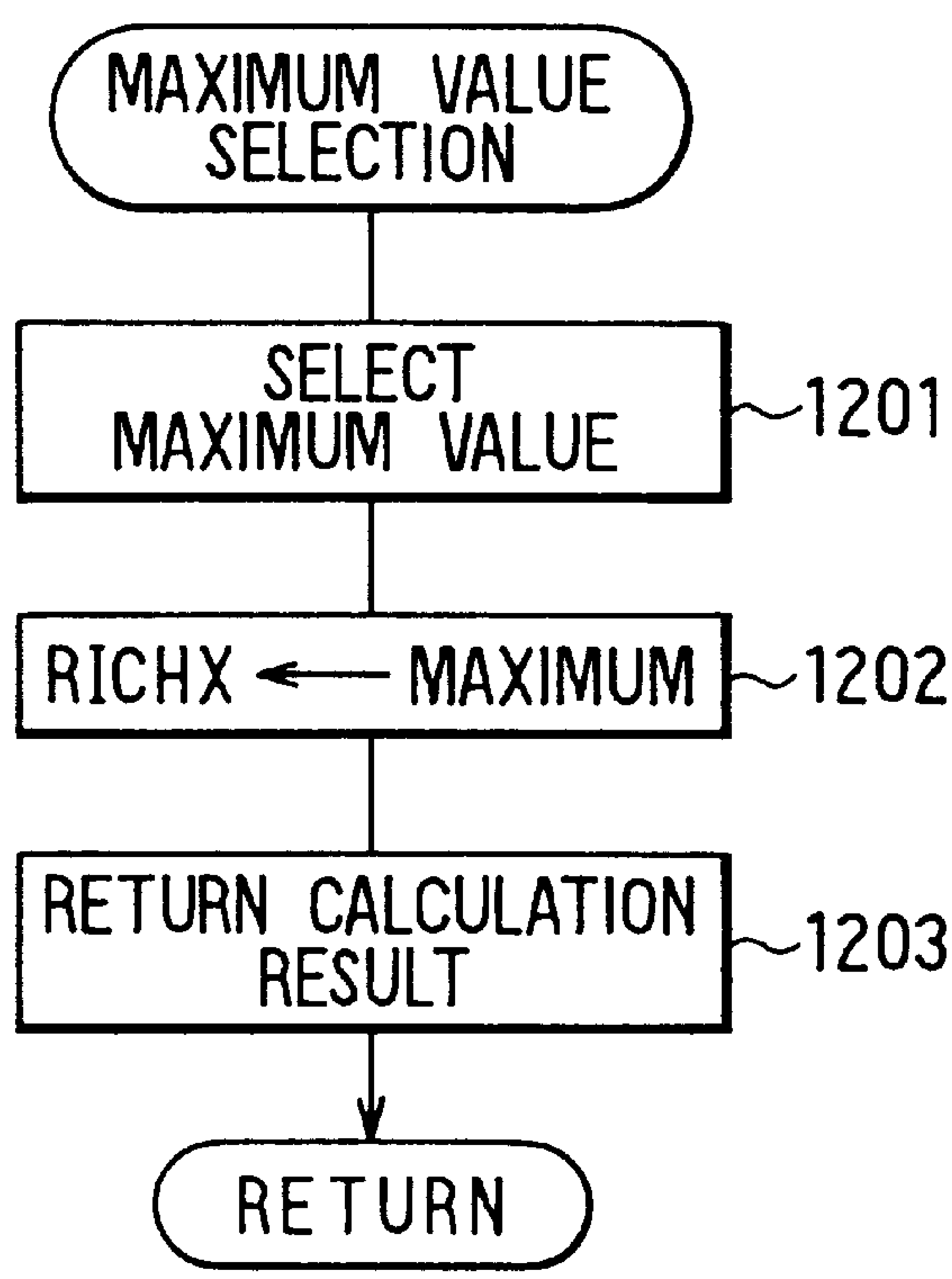

MAXIMUM VALUE SELECTION
SELECT MAXIMUM VALUE
1201
RICHX ← MAXIMUM
1202
RETURN CALCULATION RESULT
1203
RETURN

FIG. 13

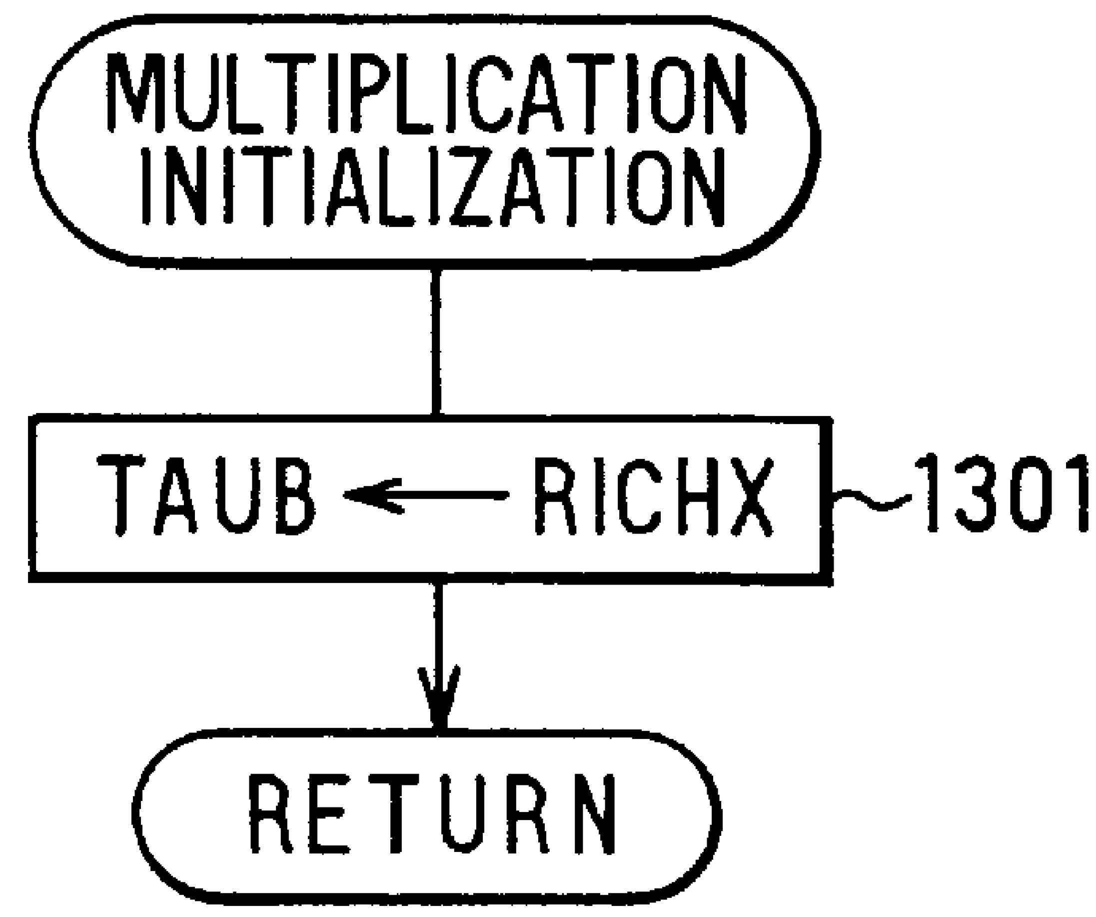


FIG. 14

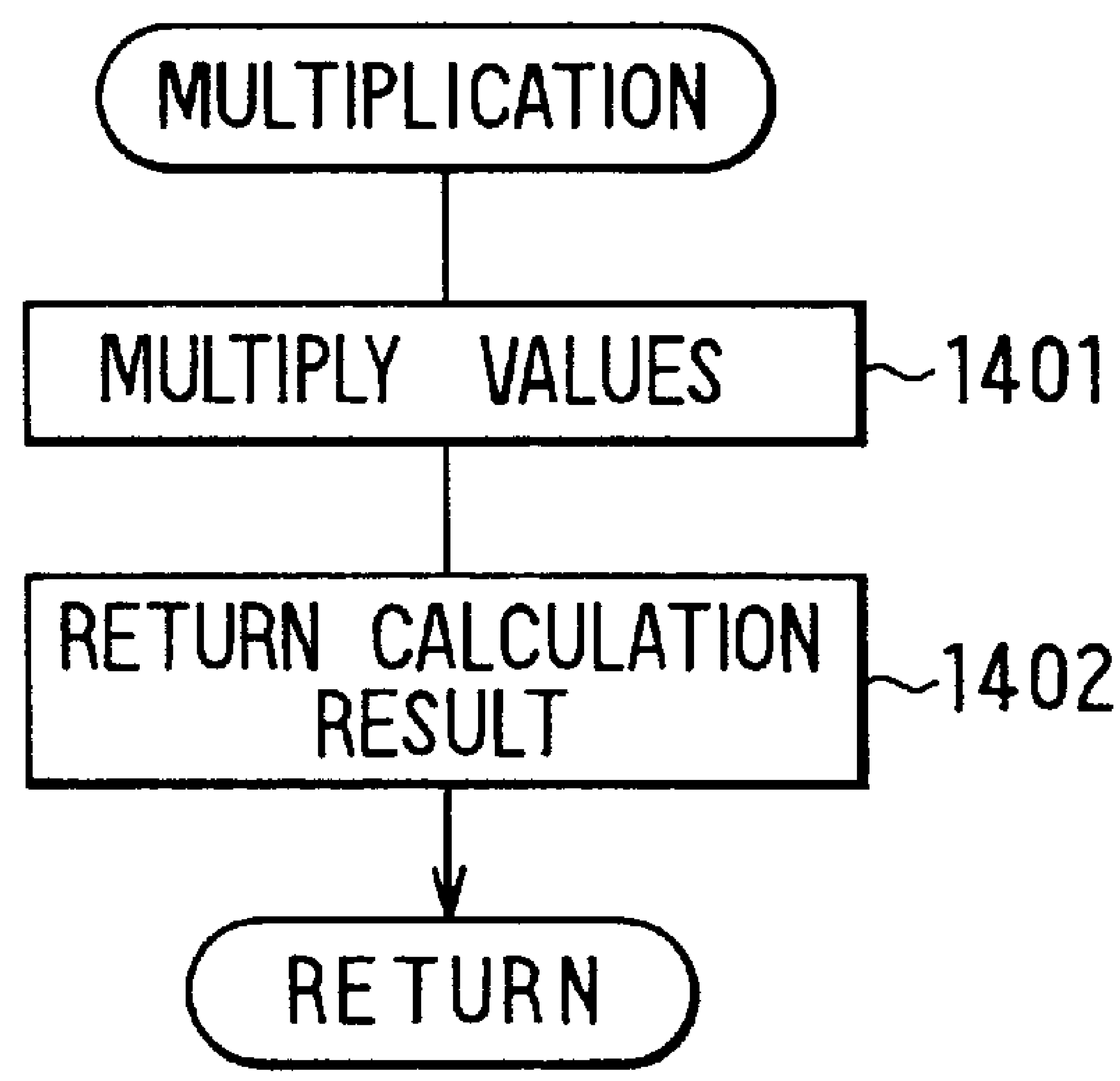
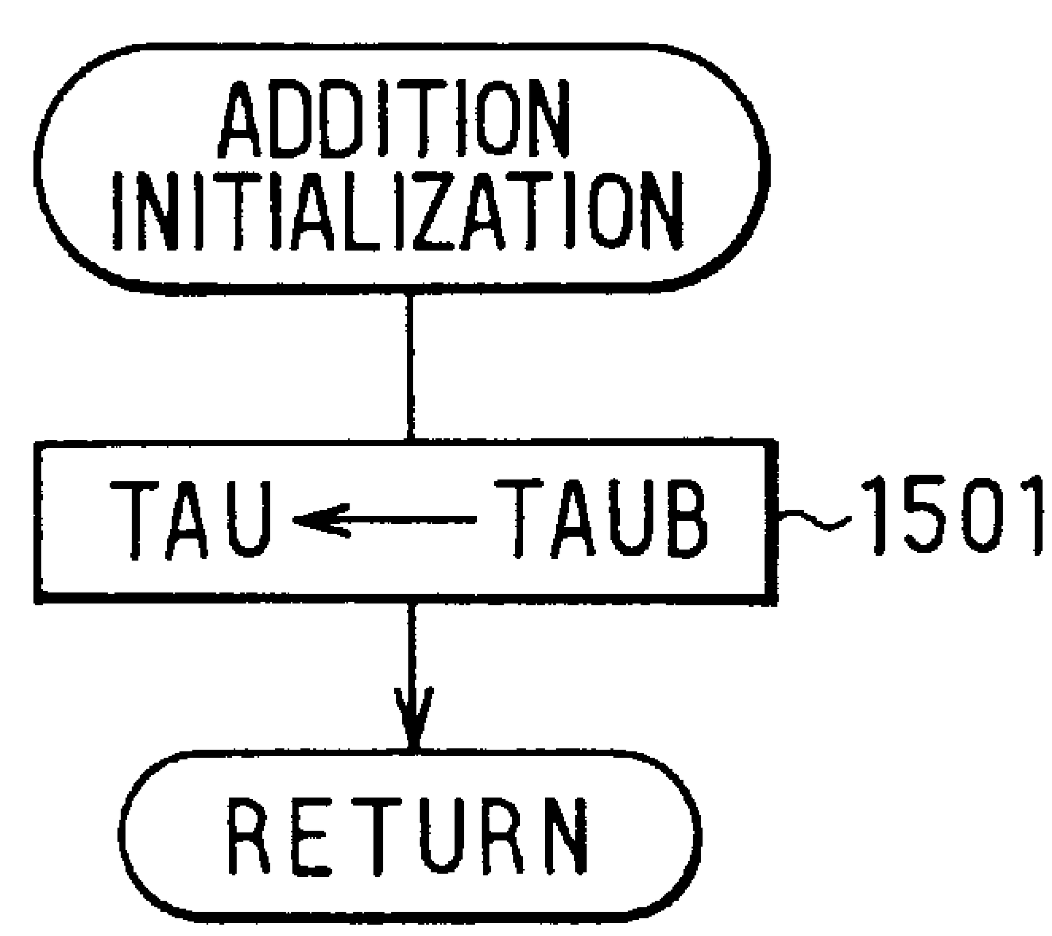


FIG. 15



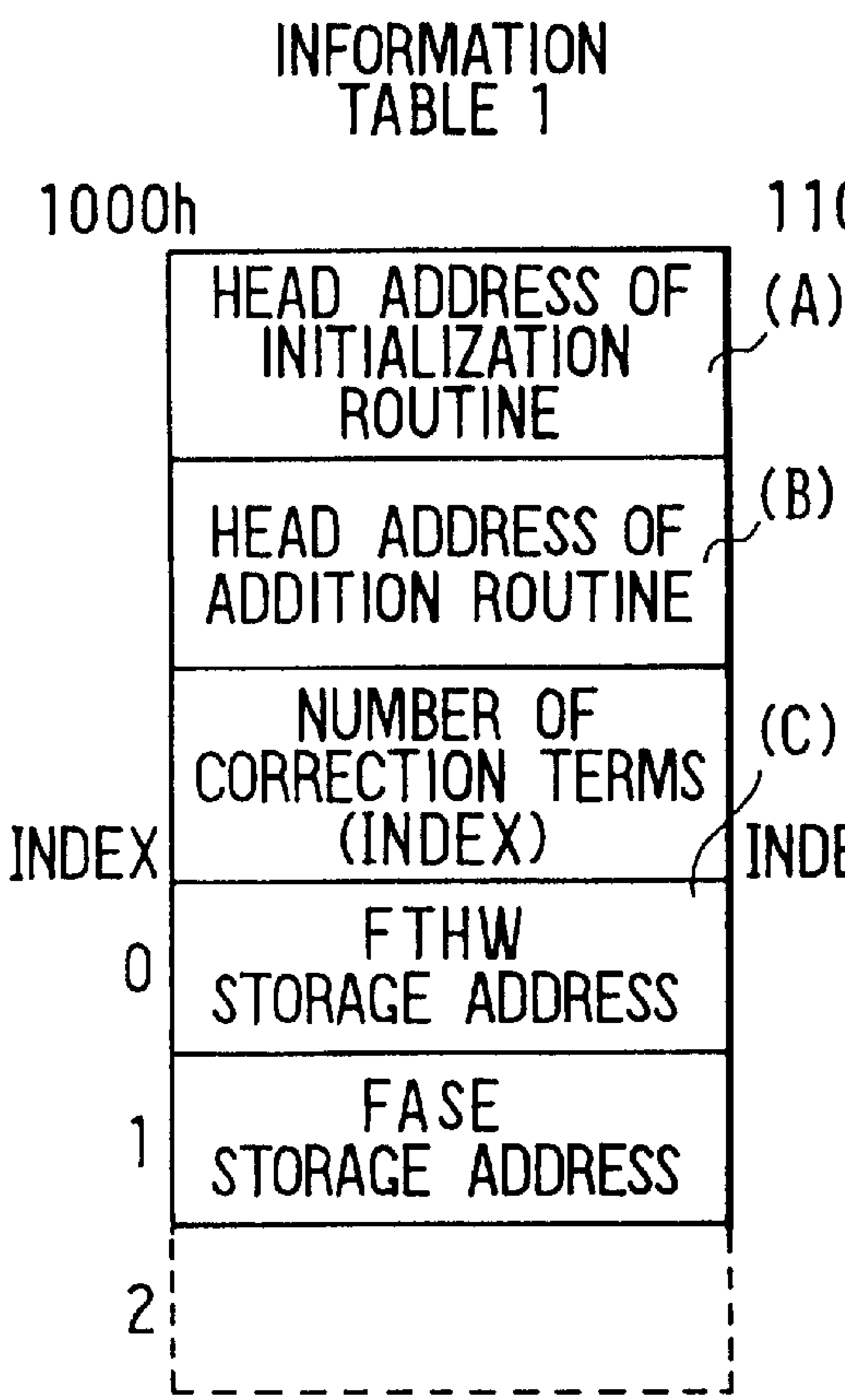


FIG. 16A

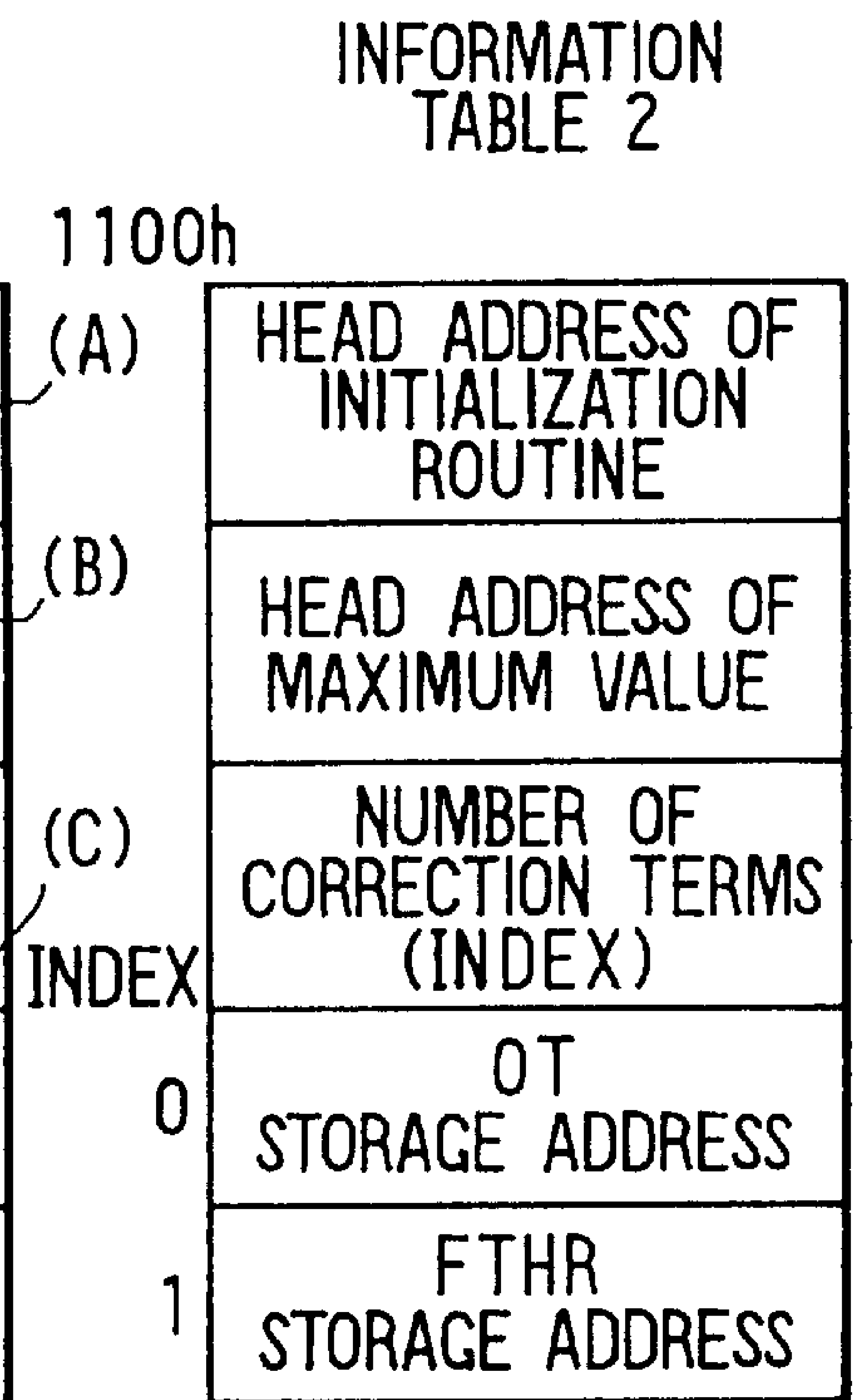


FIG. 16B

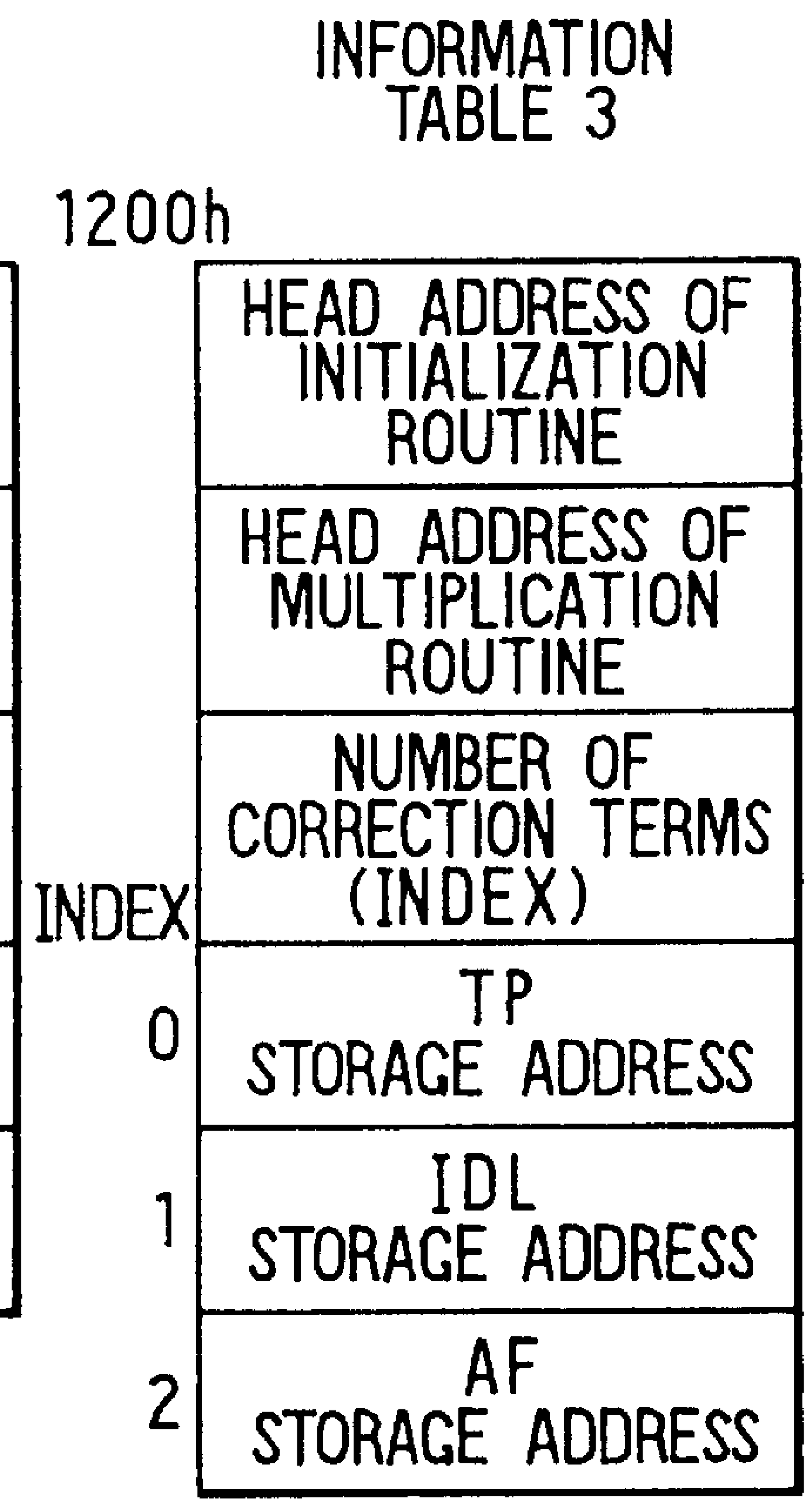


FIG. 16C

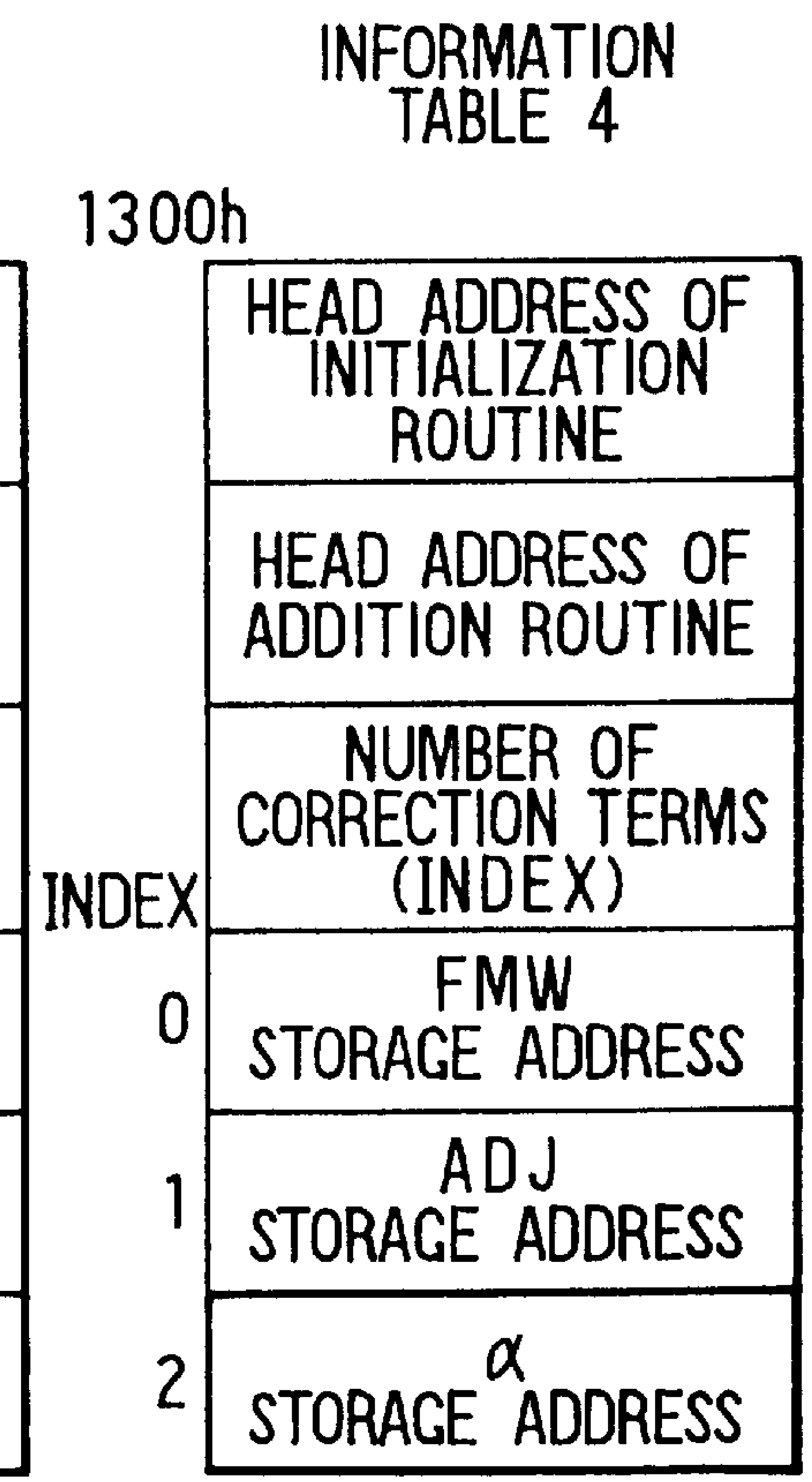
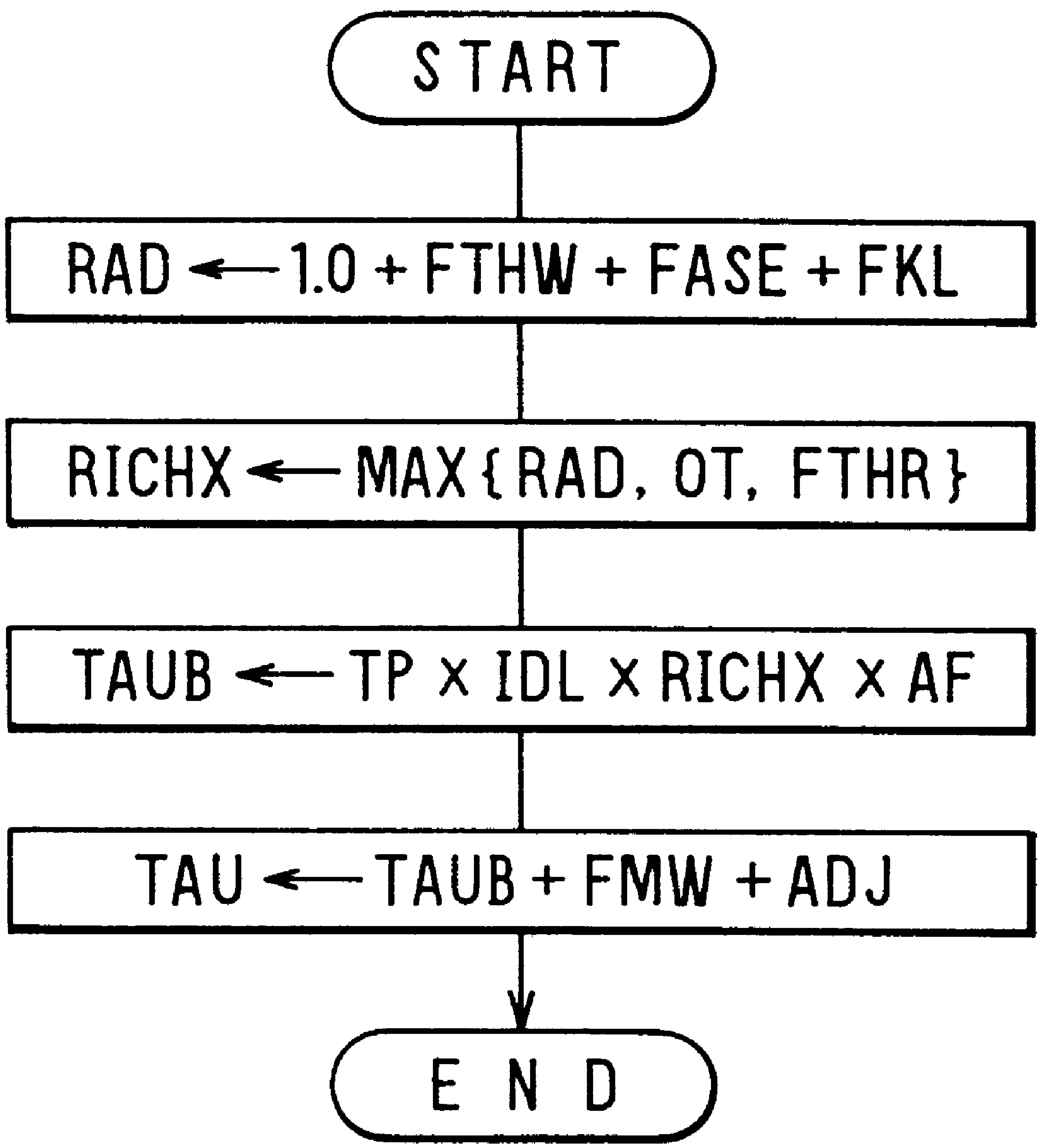


FIG. 16D

FIG. 17
PRIOR ART



VEHICLE CONTROL APPARATUS FOR CALCULATING CONTROL VALUE WITH BASIC VALUE AND CORRECTION VALUE

CROSS REFERENCE TO RELATED APPLICATION

This application relates to and incorporates herein by reference Japanese Patent application No. 10-274884 filed on Sep. 29, 1998.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a vehicle control apparatus, and more particularly to a control apparatus which calculates a final vehicle control value based on a basic value and a correction value varying with operating conditions of a vehicle.

2. Description of Related Art

An internal combustion engine for vehicles, for instance, is controlled by an electronically-controlled fuel injection apparatus. This apparatus calculates a basic fuel injection value (fuel injection duration) Tp based on the detection values of an engine rotation speed and an intake air pressure (intake air quantity), and various correction values based on engine operating conditions and various mechanical characteristics of the engine. The apparatus calculates a final injection value (duration) TAU based on the calculated basic value and correction values to drive fuel injectors for the final value TAU for fuel injection.

More specifically, the apparatus executes various calculations in the order shown in FIG. **17** to calculate the final injection value TAU from the basic value TP and the following exemplary correction values.

FTHW: warm-up fuel enrichment correction for increasing fuel for engine warm-up in accordance with engine coolant temperature;

FASE: after-start fuel enrichment correction for increasing fuel after engine starting;

FKL: small air enrichment correction for increasing fuel in case of small intake air quantity;

RICHX: enrichment correction for increasing fuel in accordance with a maximum of radiator temperature RAD, catalyst over-temperature OT and the like;

IDL: idling correction for increasing and decreasing fuel to prevent engine stall at the time of engine idling;

AF: air-fuel ratio correction for increasing and decreasing fuel to maintain the air-fuel ratio of air-fuel mixture;

FMW: wall-sticking fuel correction to increase fuel amount in correspondence with sticking of injected fuel around an engine intake valve; and

ADJ: adjustment correction for increasing and decreasing fuel from an external side.

The above calculation processing must be changed from engine to engine and vehicle to vehicle, because the characteristics of engines and vehicles are different from each other. For instance, additional correction values may have to be calculated in some types of engines, and some of the above correction values may have to be omitted in other types of engines.

It is thus required to check a control program of the control apparatus and modify the same, each time the type or specification of the engine or vehicle is changed. This program check and modification requires an enormous program development or modification workload, because it is very difficult to find out the sections in the program to be modified. Thus, it is almost impossible to use the program for one apparatus to another apparatus.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a control apparatus for vehicles, which is capable of being used for different types of vehicles with only a modification to a program section related to corrections values.

According to the present invention, a control apparatus has a designation information table and a correction information table. The correction information table stores address data of calculation routines of different types and address data in which correction terms are stored. A processing unit calls functions designated in the information tables to calculate a control value in its control value calculation processing. In the event that the control specifications are required to be changed, only a part of the correction information table is modified, thus enabling the reuse of a control program of the processing unit.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and advantages of the present invention will become more apparent from the following detailed description made with reference to the accompanying drawings. In the drawings:

FIG. **1** is a schematic view showing an engine control system to which a control apparatus according to an embodiment of the present invention is applied;

FIG. **2** is a block diagram showing the control apparatus shown in FIG. **1**;

FIG. **3** is a flow diagram showing a fuel injection duration (TAU) calculation routine executed in the embodiment;

FIG. **4** is a flow diagram showing a fuel injection effecting routine executed in the embodiment;

FIG. **5** is a flow diagram showing a routine for selecting designation information tables;

FIG. **6** is a schematic view showing a format of the designation information tables used in the embodiment;

FIG. **7** is a flow diagram showing a correction processing routine executed in the embodiment:

FIG. **8**A to **8**D are schematic diagrams showing formats of the correction information tables used in the embodiment;

FIG. **9** is a flow diagram showing an addition initialization routine executed in the embodiment;

FIG. **10** is a flow diagram showing an addition processing routine executed in the embodiment;

FIG. **11** is a flow diagram showing a maximum value initialization routine executed in the embodiment;

FIG. **12** is a flow diagram showing a maximum value selection processing routine executed in the embodiment;

FIG. **13** is a flow diagram showing a multiplication initialization routine executed in the embodiment;

FIG. **14** is a flow diagram showing a multiplication processing routine executed in the embodiment;

FIG. **15** is a flow diagram showing an addition initialization routine executed in the embodiment;

FIGS. **16**A to **16**D are schematic diagrams showing modified formats of the correction information tables shown in FIG. **8**; and

FIG. **17** is a flow diagram showing a fuel injection duration calculation routine executed in a conventional control apparatus.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention will be described hereunder with reference to an embodiment, which is directed to an electronic control apparatus for controlling fuel injection operations of a multi-cylinder spark-ignited internal combustion engine.

Referring first to FIG. **1**, an engine control system **10** has an internal combustion engine **20**. The engine **20** has at its intake side an air cleaner **12**, an accelerator-linked throttle valve **13** and a surge tank **14**. The engine **20** also has at its exhaust side an exhaust valve **23**, an exhaust manifold **24** and a catalytic converter **25**. An intake air temperature sensor **15** is mounted in the air cleaner **12**, and a throttle position sensor **16** is coupled with the throttle valve **13**. A vacuum sensor **17** is mounted on the surge tank **14**.

The surge tank **14** is in communication with combustion chambers **21** of the engine **20** through intake manifolds **18** and intake valves **19**, respectively. Fuel injectors **22** are mounted in the intake manifolds **18**, so that each fuel injector **22** injects pressurized fuel for each cylinder.

A rotation position sensor **26** is provided in an ignition distributor. An engine coolant temperature sensor **27** is mounted on an engine block **28**, and an oxygen (O_2) concentration sensor **29** is mounted upstream the catalytic converter **29**.

Those sensors are connected to a microcomputer **11**, which calculates fuel injection duration in response to the detected engine operating conditions and drives the fuel injectors **22**. The microcomputer **11** also controls ignitions of the engine **20**.

As shown in detail in FIG. **2**, the microcomputer **11** comprises a central processing unit (CPU) **11***a*, a read only memory (ROM) **11***b* storing processing programs, a random access memory (RAM) **11***c* for storing temporary data, a backup RAM **11***d* for storing data even during an engine rest, an input interface circuit **11***e*, an analog/digital (A/D) converter **11***g* with a built-in multiplexer, and an input/output (I/O) interface circuit **11***f*. Those units are connected through a bus **11***i*.

The analog/digital converter **11***g* receives sequentially an intake air temperature signal, a throttle position signal, an intake air pressure (PM) signal, a water coolant temperature signal and an oxygen concentration signal of the sensors **15**, **16**, **17**, **27** and **29** in a time-divided multiplexing method, and sequentially converts analog values of those signals into corresponding digital values to be transmitted through the bus **11***i*.

The input/output interface circuit **11***f* receives a throttle position pulse signal and a rotation pulse signal (NE) of the sensors **16** and **26** and transmit those to the CPU **11***a* through the bus **11***i*. The interface circuit **11***f* also applies a fuel injection signal produced from the CPU **11***a* to the fuel injector **22**, so that the fuel injector **22** injects fuel for a duration (TAU) of the fuel injection signal.

The CPU **11***a* operates to execute control programs stored in the ROM **11***b* as shown in the following flow diagrams.

As shown in FIG. **3**, a fuel injection quantity, which is defined as a fuel injection duration (TAU), is calculated in a fuel injection duration calculation routine as a base routine. In this routine, the CPU **11***a* reads in the digital values of intake air pressure PM and engine rotation speed NE at step **301**, calculates a basic fuel injection duration TP as PM/NE at step **302**, and stores the calculated duration TP in a specified address in the RAM **11***c* at step **303**.

Then, the CPU **11***a* calculates various correction values for an engine warm-up enrichment, an air-fuel ratio feedback and the like at step **303**, and stores the same in specified addresses in the RAM **11***c*. The CPU **11***a* corrects the calculates a final fuel injection duration TAU by correcting the calculated basic duration TP with the calculated correction values at step **304**, and stores the same in a specified address in the RAM **11***c* at step **305**. The CPU **11***a* then proceeds to another base routine.

The CPU **11***a* executes a fuel injection effecting routine shown in FIG. **4** at every specified engine rotation position (angle). Specifically, the CPU **11***a* checks at step **401** whether it is an injection timing. If it is the injection timing (YES), the CPU **11***a* reads in at step **402** the injection duration TAU calculated in the TAU calculation routine (FIG. **3**), and produces at step **403** a drive pulse having a time period of TAU to effect fuel injection from the injector **22**.

The correction value calculation at step **303** (FIG. **3**) is described in further detail with reference to FIGS. **5** to **16**.

Referring to FIG. **5**, the CPU **11***a* resets at step **501** a variable k, which designates an address of an information table to be retrieved for information referencing. The information table is shown in FIG. **6**. The CPU **11***a* then retrieves at step **502** the address data of the information table **1** to be referred to in correspondence with the variable k. For instance, if k=0 (area 0), an address data **1000***h* is read out to refer to the information table **1**, and an information table **1** shown in FIG. **8**A is selected. The CPU **11***a* calls at step **503** a correction processing routine shown in FIG. **7**, so that the processing in the information table of FIG. **8**A is executed.

The CPU **11***a* increments the variable k at step **504** to designate the information table number to be referred to next time. Thus, the address data of the information tables are read out in the order of the **1100***h*, **1200***h* and **1300***h*, so that the information tables are sequentially read out from the table **1** to table **4** to execute the processing defined in the information tables **1** to **4** in the routine of FIG. **7**.

The CPU **11***a* then compares the variable k with the maximum number n (n=4) of the information tables at step **505** to check if all the information tables **1** to **4** have been referred to. If k<n (YES), the CPU **11***a* repeats steps **502** to **504**. If not (NO), the CPU **11***a* returns to step **304** in FIG. **3**, thus completing the routine of FIG. **5**.

In the routine shown in FIG. **7**, the CPU **11***a* calls at step **701** an initialization (initial setting routine) based on the data defined in the head address of the information table retrieved at step **502** (FIG. **5**). More specifically, an addition initialization routine is called first based on a head address data (A) of the initialization routine defined in the information table **1** corresponding to the address **1000***h* designated at a timing of resetting the variable (k=0). In the addition initialization routine, as shown in FIG. **9**, an initial value 1.0 is set as a correction term RAD at step **901**.

The CPU **11***a* then resets at step **702** an index INDEX, which is for designating sequentially the correction terms of the information table, and specifies at step **703** the address, in which the correction term to be used in the correction calculation is stored, by searching for the information table **1** from the INDEX value (0, 1, 2 and the like). At step **704**, the CPU **11***a* reads out data of the correction term from the address specified at step **703**. For instance, if INDEX=0, the address storing a basic warm-up correction value FTHW is searched and specified by the information table **1** ((C) in FIG. **8**A), the basic warm-up correction value FTHW is read out from the corresponding address.

Then, the CPU **11***a* calls a calculation processing routine at step **705** based on the data stored in a specified address in the information table, that is, the data stored next to the address data of the initialization routine ((B) in FIG. **8**A). Here, if the variable k=0, the addition processing routine is called based on the information tables **1** shown in FIG. **8**A to execute the addition routine shown in FIG. **10**. In the addition routine, the initial value 1.0 of the correction term RAD and the basic warm-up correction value FTHW are added at step **1001** at first, and then at step **1002** the addition resulting value is returned to the correction routine shown in FIG. **7**.

The CPU **11***a* then increments the INDEX at step **706**, and compares the INDEX and the number N of the correction terms stored in the information table at step **707** to check whether all the correction terms designated in the information table have been calculated. The processing returns to step **703** because the INDEX is initially less than N (YES). The addition routine shown in FIG. **10** is called again at step **705**, so that the addition accumulated value and the correction terms specified newly by the INDEX are added sequentially. By the repetition of the above calculation processing, the calculation of RAD=1.0+FTHW+FASE+FKL is completed. The processing then returns to step **503** (FIG. **5**), if it is determined at step **707** that INDEX has reached N.

As described above, the CPU **11***a* increments the variable k at step **504**, and compares the variable k with the number of information tables n at step **505** to check whether all the calculations required for the calculation of the fuel injection duration TAU have been completed. The number of information tables n is defined in the table shown in FIG. **6** in advance. Since four information tables are provided in this embodiment (n=4), the value k is incremented to k=1 (area 1) after the processing of the addition routine (k=0). Thus, the next address data **1100***h* is read out to execute the next information table **2**.

The CPU **11***a* similarly calls the calculation routine of FIG. **7** again at step **503** and searches the information table in the similar manner. A maximum value initialization routine shown in FIG. **11** is executed this time with reference to the information table **2** shown in FIG. **8**B.

In FIG. **11**, the correction term RAD is copied to a correction term RICHX at step **1101**. The CPU **11***a* executes the processing of steps **703** and **704**, and calls the calculation routine at step **705** so that a maximum value selection routine is executed as shown in FIG. **12**.

In maximum value selection routine (FIG. **12**), the CPU **11***a* compares the correction term RICHX with a catalyst over-heating prevention correction value OT at **1201**, sets the larger one as the correction term RICHX at step **1202**, and the set result is returned to the correction routine (FIG. **7**) at step **1201**. The CPU **11***a* increments the INDEX, and compares the correction term RICHX with an engine acceleration enrichment correction value FTHR. Thus, a maximum one of the three correction values are calculated finally.

Then the value k is incremented to k=2 (area 2) at step **504** (FIG. **5**), so that the next address data **1200***h* is read out to execute the next information table **3**.

The CPU **11***a* similarly calls the calculation routine of FIG. **7** again at step **503** and searches the information table in the similar manner. A multiplication initialization routine shown in FIG. **13** is executed this time with reference to the information table **3** shown in FIG. **8**C.

In FIG. **13**, the CPU **11***a* copies the correction term RICHX to the correction term TAUB at step **1301**. The CPU **11***a* executes the processing of steps **703** and **704**, and calls the calculation routine at step **705** so that a multiplication routine is executed as shown in FIG. **14**. In the multiplication routine, the CPU **11***a* multiplies at step **1401** sequentially the basic injection quantity TP, an engine stall prevention correction value IDL and an air-fuel ratio correction value AF to the correction term TAUB to determine a final correction term TAUB.

Then the value k is incremented to k=3 (area 3) at step **504** (FIG. **5**), so that the next address data **1300***h* is read out to execute the next information table **4**.

The CPU **11***a* similarly calls the calculation routine of FIG. **7** again at step **503** and searches the information table in the similar manner. An addition initialization routine shown in FIG. **15** is executed this time with reference to the information table **4** shown in FIG. **8**D.

In FIG. **15**, the CPU **11***a* copies the correction term TAUB to a correction term TAU at step **1501**. The CPU **11***a* executes the processing of steps **703** and **704**, and calls the calculation routine at step **705** so that the addition routine shown in FIG. **10** is executed. Here, because the calculation of the correction terms designated in the information table **4** is also the addition processing, the addition routine shown in FIG. **10** is called as in the case of the information table **1**. Thus, the processing program shown in FIG. **10** may be used commonly, thus reducing the storage capacity of the memory which stores the programs.

At step **1001** in FIG. **10**, the addition is executed in the similar manner to add sequentially a wall-sticking fuel correction value FMW and an external adjustment correction value ADJ to the copied value TAU to determine the fuel injection duration TAU as the final control quantity. Thus, the CPU **11***a* returns to step **503**, determines at step **305** that all the required calculations have been completed, and returns to step **305** to store the calculated final injection duration TAU.

In the event of applying the programs for one type of engine to another type of engine, the information tables **1** to **4** shown in FIGS. **8**A to **8**D are modified. For instance, if the calculation of the injection duration TAU requires another correction value α and the small air enrichment correction value FKL is not required, the information tables **1** to **4** may be only partly changed.

Specifically, as shown in FIGS. **16**A to **16**D, INDEX2 is added to the information table **4** (FIG. **16**D) to register therein data indicative of the address in which the correction value α is stored, and the information regarding the correction value FKL of INDEX2 in the information table **1** is eliminated. That is, the changes are made only by the number of correction terms (the number of INDEX) in each information table. Thus, the programs for calculating the correction terms need not be changed at all, thereby enabling the programs to be applied to different types of engines and reducing remarkably the program development workload.

Further, even in the event that a change is required such that the external adjustment correction value ADJ is determined by a multiplication of correction terms β and γ, this change may be attained by only additionally providing the information tables regarding the correction terms β and γ and additionally providing a table between k=2 and k=3 in the designation information table shown in FIG. **6**.

As described above, no changes are required to the actual calculation processing programs such as shown in FIGS. **7** and **10**, no debugging of those calculation programs are needed thereby remarkably improving the program development work efficiency.

Although the present embodiment is described with reference to the processing of calculating the fuel injection duration TAU only, the similar processing may be implemented in the ignition control and the idle speed control as well. Further, the processing of FIG. **7** may be used commonly for both of the ignition timing calculation and the fuel injection duration calculation.

What is claimed is:

1. A control apparatus for vehicles comprising:

a plurality of correction information tables for storing a plurality of address data indicating types of correction calculations, and a plurality of correction terms to be calculated based on operating conditions in dependence on the types of correction calculations;

a designation information table for designating sequentially the plurality of correction information tables based on the types of correction calculations; and

a processing unit for executing a fixed control program to sequentially refer to said designation information table to thereby sequentially designate and refer to said plurality of correction information tables for calculating sequentially a plurality of control values based on the address data and the correction terms, and calculating a final control value from the sequentially calculated control values.

2. A control apparatus as in claim **1**, wherein the designation information table has:

areas for storing a table number of the plurality of correction information tables; and

a plurality of areas for storing head addresses of the plurality of correction information tables.

3. A control apparatus as in claim **1**, wherein results from calculating sequentially a plurality of control values is changed by modifying said correction information tables only.

4. A control apparatus as in claim **3**, wherein said correction data tables are modified by eliminating and/or adding at least one of said correction terms.

5. A control apparatus for vehicles comprising:

a plurality of correction information tables for storing a plurality of address data indicating types of correction calculations, and a plurality of correction terms to be calculated based on operating conditions in dependence on the types of correction calculations;

a designation information table for designating sequentially the plurality of correction information tables based on the types of correction calculations; and

a processing unit for calculating sequentially a plurality of control values based on the address data and the correction terms with reference to the correction information tables designated by the designation information table, and calculating a final control value from the sequentially calculated control values;

wherein each of the plurality of correction information tables has:

an area for storing a head address of an initialization routine;

an area for storing a head address of a calculation processing routine of each type of correction calculations;

an index area for storing the number of correction terms; and

a plurality of correction term areas for storing address data of the type of correction calculation for each index.

6. A control apparatus as in claim **5**, wherein the plurality of correction terms in the correction information table is capable of being changed by elimination and addition.

7. A control apparatus for vehicles comprising:

a plurality of sensors for sensing operating conditions of a control object;

a processing unit for calculating a control value for the control object based on the sensed operating conditions, the control value being a function of a plurality of correction terms; and

a memory including a control program defining a calculation operation of the processing unit, and a plurality of tables to be referred to during an execution of the control program by the processing unit,

wherein the control program is fixed independently of types of the control object and the tables are variable in dependence on the types of the control object;

the tables includes:

a plurality of correction information tables for storing a plurality of address data indicating types of correction calculations, and the plurality of correction terms to be calculated based on the operating conditions in dependence on the types of correction calculations; and

a designation information table for designating sequentially the plurality of correction information tables based on the types of correction calculations, said control program sequentially referring to said designation information table to sequentially designate and refer to the plurality of correction information tables.

8. A control apparatus as in claim **7**, wherein results from calculating a control value are changed by modifying said correction information tables only.

9. A control apparatus as in claim **8**, wherein said correction information tables are modified by eliminating and/or adding at least one of said correction terms.

10. A control apparatus development method for vehicles comprising the steps of:

fixing, independently of a type of a control object, a control program for calculating a control value for the control object based on sensed operating conditions, the control value being a function of a plurality of correction terms; and

changing, in response to a change in the type of the control object, a plurality of tables to be referred to during an execution of the control program by the processing unit,

wherein the tables includes:

a plurality of correction information tables for storing a plurality of address data indicating types of correction calculations, and the plurality of correction terms to be calculated based on the operating conditions in dependence on the types of correction calculations; and

a designation information table for designating sequentially the plurality of correction information tables based on the types of correction calculations, said control program sequentially referring to said designation information table to sequentially designate and refer to the plurality of correction information tables.

11. A control apparatus as in claim **10**, wherein results from calculating a control value are changed by modifying said correction information tables only.

12. A control apparatus as in claim **11**, wherein said correction information tables are modified by eliminating and/or adding at least one of said correction terms.

13. A method of controlling a control object by a processing unit which executes a control program stored in a memory, the method comprising steps of:

calculating, by executing a first part of the control program, a basic control value based on first predetermined operating conditions of the control object;

calculating, by executing a second part of the control program, a plurality of correction values based on second predetermined operating conditions of the control object;

calculating, by executing a third part of the control program, a final control value by correcting the calculated basic control value with the calculated plurality of correction values; and

driving, by executing a fourth part of the control program, the control object by an amount corresponding to the calculated final control value;

wherein executing said second part of the control program includes steps of:

referring sequentially to a designation table stored in the memory which designates a plurality of correction data tables stored in the memory to designate the correction data tables one by one; and

referring sequentially to the correction data tables in the order as designated by the designation table to determine the correction values one by one.

14. A control apparatus as in claim **13**, wherein results from calculating a final control value can be changed by modifying said connection data tables only.

15. A control apparatus as in claim **14**, wherein said correction data tables are modified by eliminating and/or adding at least one of said correction terms.

* * * * *